A QUARTERLY JOURNAL OF METHODS AND INFORMATION FOR TEACHERS OF SCIENCE

The SCIENCE COUNSELOR

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"FOR BETTER SCIENCE TEACHING"

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In Future Numbers . . .

The September 1961 issue of The Science Counselor will be under new editorship. The new editor will be Doctor Marc A. Shampo of the Duquesne University School of Education.

The press of other duties has forced the present editor to resign.

We wish the new editor success. We thank all who have helped us in the past and ask their continued cooperation with our new editor. —*J.P.M.*

A Generation of High School Calculus

• J. H. Neelley, Ph. D. (*Yale University*)
CARNEGIE INSTITUTE OF TECHNOLOGY

The final test of the efficacy of accelerated high school programs is the achievement of the participants during four years of college. Doctor Neelley has completed a four year study of the performance of high school calculus students in his institution.

This paper was presented before the annual conference of the Mathematics Council of Western Pennsylvania in March, 1961, and before the Mathematical Association of America in May, 1961.

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For the past four years we have had freshmen come to Carnegie Institute of Technology with some high school calculus. We have tried to meet the desires of these freshmen in several ways. The first group was integrated with second semester students. This was very unsatisfactory. The following three groups have been kept apart and have been given a course in calculus and analytics to cover four semesters in two. This course has varied some in the amount of analytics as a full course proved to be too much.

I have watched carefully these accelerated students and am now able to report on our first college generation of such!

In 1956, the press, politicians and then the public began to demand that the high schools do the work equivalent to that done in Europe under a very different situation. This did create the high school accelerated programs. So, in 1957–58, we had 13 freshmen register as majors in mathematics, whereas, before then we had had less than 5 each fall. This pressure has gradually increased our mathematics majors to 32 in 1958–59, 37 in 1959–60 and this year to 46 for 1960–61.

In these four years the freshman classes have had an increased number of accelerated high school students. Only 6 in 1957–58, 48 in 1958–59, 33 in 1959–60 and 54 in 1960–61.

These are our brightest students and so it is interesting to see how they have registered in college. The first year, 2 of the 6 registered for mathematics as major. The second year 5, then the third year 8 and this year 5.

These figures are surprising. When only 5 out of 54 register for mathematics as major when at the same time we have 46 so register from the freshman class, we are shocked. This carries on the whole four years, 2 of 13, 5 of 32, 8 of 37 and 5 of 46. So our mathematics majors are not coming in large numbers from the high school accelerated groups.

Also it is interesting to see how the accelerated group holds its own in college. The first group of 2 dropped to 1 in short order. This is the year we had 13 mathematics majors. Today this class is the senior and the pressure has made it grow from 13 to 20 with only 1 accelerated student.

The 1958–59 group started at 48 and only 11 completed the first year of college work. There were 5 who originally registered as mathematics majors and today, as juniors, only 3 of them are still such. This is 3 out of 25 juniors today.

The 1959–60 group started at 33 and 18 finished the first year of college mathematics. This course was cut some as compared to the 1958–59 one. Today we have 31 sophomores who are mathematics majors and only 4 of that original group are still such.

Our fourth year, 1960–61 saw 54 freshmen come with high school calculus and today we have 46 freshmen mathematics majors with only 5 of them from the accelerated high school group. The 54 is now down to 17 and the first year is not completed.

To summarize the generation, out of 1700 engineering and science freshmen, 141 came to us with high school calculus. As of now, we have 14 or only 10 per cent of that group as mathematics majors. This is even more srtiking in that we now have 122 mathematics majors in Tech.

These figures seem surely to point to two things. First, high school acceleration is not the way to increase our number of college majors in mathematics. Second, the high casualty in the accelerated college courses make it seem that "high school calculus is largely a waste of time."

So, please, let me urge you of the high schools, to teach high school mathematics. There is enough of it to keep even bright students busy. And please let the colleges teach the college courses.

Then, and finally, if you of the colleges will interest yourselves in your prospective students, please study this and other reports I have made and encourage the high schools in your various regions to control their courses accordingly.

TABLE I

	1957 1958	1958 1959	1959 1960	1960 1961
Entering Freshmen with High School Calculus	6	48	33	54
Math Majors in Freshman Class	13	32	37	46
Math Majors from High School Calculus Group	2	5	8	5
Total Math Majors in Spring 1961	20	25	31	46
High School Calculus Group Math Majors as of April 1961	1	3	4	5

TABLE II

Accelerated Course at Tech			
	1958–59	1959–60	1960–61
Number with High School Calculus Starting	16 (48)*	24 (33)*	21 (54)*
Number Completing One Year	11	18	17

* Numbers in parentheses denote entering freshmen with high school calculus.

The Operational Aspect of Physical Science

• by **Andrew G. Van Melsen, D.Sc.** (*University of Utrecht*)
DIRECTOR OF SCIENCE FACULTIES, UNIVERSITY OF NYMEGEN

The following is adapted from a chapter of the book "Science and Technology," which will be published by Duquesne University Press in the fall of 1961.

Doctor Van Melsen is the author of "From Atomos to Atom."

Interdependence of Knowing and Doing

Meanwhile the analysis of what happens in an experiment teaches us that there is an intimate interdependence not only between sense knowledge and intellectual knowledge but also between knowing and doing. For the possibility of the senses to register something in the experiment depends upon a previous intervention of man in reality. Things have to be acted upon by an activity of our hands before the senses are enabled to penetrate into what we want to see. This operational activity, however, itself depends again upon our knowledge. Here also, there is a mutual dependence. At the same time it follows that physical science and technique are essentially related. There is no physical science which is a purely cognitive activity, just as there is no technique which is purely a manipulation of reality.

Generally the dependence of technology upon physical science is more easily grasped than that of physical science upon technology. For this reason technology is sometimes called "applied science." This term, however, is just as correct or incorrect as is that of "applied technology" for physical science. Both terms are correct insofar as the knowledge of physical science can be obtained only by technical means and insofar as technical achievements are only attainable through the application of physical science. Both are incorrect insofar as the meaning of technology does not lie in the application of physical science or that of physical science in the application of technology. We will see more about this point later.

Meanwhile it should be evident that in man's activity upon matter, whether his purpose be knowing or doing, both forms of activity, knowing and doing, are inseparably connected. This interconnection is a result of the bond between intellectual and sensitive knowledge. Because sense knowledge is always limited and dependent on one's standpoint, in the literal sense of the term, material reality has to be manipulated to be fully perceived. The object which I take into my hands and turn around to look at it from all sides expresses the same intimate bond between the operational and the cognitive aspects which constitutes the heart of physical science as an experimental science. The interconnection between making and knowing, therefore, is not at all specific to physical science, but is typical of all human activity. At the same time, however, the remark must be made that in the old philosophy of science which we have inherited from the Greeks this interconnection was viewed more from the side of making than from that of knowing (in the sense of scientifically knowing). This way of viewing the relationship in question was, of course, conditioned by the state of development reached by Greek science.

The Early Development of Mathematics, Logic, and Philosophy

As has been pointed out repeatedly, the conditions that must be fulfilled before physical science can be born resemble somewhat a vicious circle. The theory has to be based upon experimental data, but these data themselves have to be acquired by means of the theory. For this reason it is not surprising that the first sciences to develop were those in which the separation of the relevant from the irrelevant could be accomplished by means of thought alone. This was the case with mathematics, logic, and philosophy. Thus it was possible to formulate principles covering these realms by virtue of which the interconnections existing in these realms could be deductively rendered accessible to insight.

The best example of all is provided by Euclid's mathematics. In it, the classical ideal of science came closest to realization. Somewhat less comprehensive from a modern point of view, but still surprisingly pure was the case of Aristotle's logic, in which the various forms of reasoning were seen in the light of a few fundamental ideas and shown to be interconnected. The same was true also of astronomy, in which all celestial movements were explained by means of the theory of circle movements. In these realms, therefore, the Greeks managed to reach the level of science, to unify and explain the variety of forms, shapes, movements, and phenomena.

With respect to explanations of nature, however, to the extent that such were given, they remained largely on the philosophical level. They were mostly considerations regarding change in general, but hardly about specific processes of particular changes. Of course, particular changes also were mentioned and described, but their specific development was not explained in its details by means of general principles. Explanatory theories, such as the matter-form theory of Aristotle or the atomic theory of Democritus, aimed at the possibility and nature of change in general. In the Greek phase of science it was not yet possible to connect the detailed items of knowledge about material things and their properties by means of scientific interrelationships. Physical science remained limited to practical experimental knowledge, especially knowledge that was important for the use and the shaping of the various materials. Thus, as far as technique was concerned, there was an intimate connection between knowing and doing, but there was no knowledge rising to the level of general science. Whatever detailed knowledge there was regarding the various materials continued to consist of disconnected items.

The Greek Concept of Pure and Disinterested Science

As could be expected, the philosophy of science of the Greeks corresponded to the actual status of their science.

Science consisted in disinterested contemplation, in knowledge for the sake of knowledge, because in such knowledge man as a spiritual being attained his own perfection. Knowledge served to enrich the knower himself and not anything outside the knower. Thus there are two striking aspects in the Greek concept of science: it is contemplative and disinterested, i.e., not directed to practical application. The contemplative character of science, however, did not exclude the empirical element. Aristotle especially emphasized the empirical character of knowledge. Nevertheless, what he considered as the empirical element of science is not quite the same as what constitutes the essence of contemporary experimental science, in which the theoretical, operational, and sensitive elements are intimately united.

Surprisingly, there is a text in which Aristotle shows that he was struck by the importance of the operational element in pure science. Speaking about the value which the drawing of auxiliary lines in a mathematical figure has for seeing the demonstration of a particular thesis, he says: "*poiountes gignoscousin,*" i.e., "by making one arrives at understanding."[1] However, this is an isolated text. There are no indications that Aristotle utilized the idea it contains in his considerations regarding theoretical science. The reason is not far to seek. Where making was closely connected with knowing, as in various arts and skills, in the technique which was based upon practical experience, making led to knowing, but not to theoretical science, at least not yet in the time of Aristotle.

The second aspect of the Greek idea of science—its disinterestedness—is likewise easily explained through the actual status of science in ancient time. Philosophical knowledge could not contribute to the increase of detailed knowledge, because it abstracted from details as such. Greek philosophy of nature made change intelligible, but it did not explain the distinct nature of the various changes in detail. This restriction does not mean that Greek philosophy must be denied any value with respect to the physical science which arose later. It does imply, however, that this value did not lie in its ability to supply a theory on the level of physical science.

So far as mathematics as a science was concerned, it too did not offer many opportunities for practical applications. Of course, mathematics did have applications—the very name "geometry," the measuring of the earth, points to this. However, what the Greeks accomplished here was precisely to lift mathematics from the sphere of applications to the level of science and to axiomatize the mathematical relationships. But this achievement was of little immediate value for practical life. Here also a long time had to pass before the accomplishment would bear fruit. It had to wait until the knowledge gained from the practical experience of natural phenomena had developed sufficiently to be ripe for mathematical treatment. Only then could it lead to scientific systematization.

The Importance of the Greek View

Meanwhile the Greek concept of mathematics as a pure science offers an impressive argument showing that their notion of the disinterestedness of science was not inspired solely by the limited possibilities of applying science that existed in their time. For mathematics could be applied and was *de facto* applied. If the Greeks had dwelled on its applicability, mathematics would not have been born as a science and, consequently, neither the physical science and scientific technology of later times. Later we will have to return extensively to the relationship between theory and practice. Although this relationship nowadays is, of course, different from that in the time of ancient Greece, at least this much is certain: precisely by emphasizing the disinterested character of scientific endeavors, the Greeks opened a road to the development of a culture in which at the proper time technique would be drawn into the sphere of science.

How correct the Greek view was is shown, moreover, also by the contemporary situation. Great and really new possibilities in the realm of technological applications continue to be disclosed not by scientific research which is directed to the application of science, but by the pursuit of science for the sake of knowing. Nuclear energy, for instance, was discovered not because a deliberate search was made for new sources of energy, but through purely speculative thinking about the data which led to the theory of relativity and through the search for an atomic structure which would explain the phenomena of radio-activity.

Accordingly, the fact that the operational aspect of scientific knowledge was at first perceived only in a dim way did not have its basis only in the undeveloped status of science. It had also a different and more general ground, which was closely connected with the reason put forward above for the priority of the theorectical element. No matter how much now, after the development of physical science, we are convinced of the value which must be attributed to its operational aspect, nevertheless even nowadays we are still inclined to see the experiment in the service of the theory rather than the theory in the service of the experiment. If it is true that the theory also serves the experiment, the reason is precisely that the theoretically guided experiment itself increases our theoretical insight. The operational factor is indispensable in the acquisition of knowledge for no other reason than that our senses are limited. Thus the operational aspect, together with the sensitive aspect, serves the theoretical aspect. It seems to play a subordinate but indispensable role. Accordingly, the priority which the Greeks attributed to the theoretical factor was not based solely upon the primitive status of their science, but also on the clear realization of the hierarchy to be assigned to the various aspects. We will have to return to this point later when we will speak about technology.

Undoubtedly, the Greeks underestimated the operational aspect of science, just as they minimized its applicational possibilities. Yet this was a *felix culpa*, a fortunate fault, which enable them to discover the essence of science where it could be discovered most easily—namely, in mathematics, logic, astronomy, and philosophy. Knowledge of nature, however, had still to travel a long road before it could attain a scientific status.

The intimate connection between the rational, the operational, and the empirical aspects of physical science is a natural extension of ordinary human knowledge. True, in the forms of science which were first discovered and pursued the rational element stood prominently and fairly exclusively in the foreground. It could hardly have been differ-

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Inorganic Side of Life, Inorganic Bioelements In Plant, Animal, and Human Health

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This paper was presented before the Indianapolis chapter of the Natural Food Associates on April 15, 1961.

At the outset it should be remembered that all matter on this earth is never destroyed or lost; only changed. Atmospheric dusts from outer space actually add to the volume and weight of our planet. The concern that our planet will be unable to support its ever increasing population is not tenable. It does however call for a larger, better, more intensified turnover of plant and animal growth and propagation to provide the volume and quality of food required. Scientific agriculture and animal husbandry are in store for us along planned engineering principles. Of necessity this is already practiced in Japan. The Oak Ridge Atom Industries Inc., Oak Ridge, Tenn., is irradiating seeds with cobalt gamma rays (cobalt 60) that have yielded plant improvements. Activated carbons and aluminum silicates can affect not only the pH but also the local magnetic fields and the electric impulses in soil materials, just as magnetism and electric impulses affect cellular activities. Consequently modern agriculture involves the study of the atoms, and the electro-magnetic forces among and within the atoms. We require to know not only the consequences from the absence of any one essential element, but also the consequences of their presence in minimum, optimum and maximum amounts. They compose the foods necessary for all forms of life, and for them we depend not only on soils, but the lithosphere, the hydrosphere and the atmosphere combined.

EACH FORM OF LIFE IS CONCERNED ONLY WITH ITS OWN GROWTH AND PROPAGATION. It may well prove possible to predetermine the crops to be grown for feed and food as to their nutrient composition, by selecting the soils and the climates best suited for any particular crop. It is also quite within the province of managerial practice to adjust all soils to grow crops of optimum nutritional quality. That these high quality crops so grown will ideally suit the needs of the consuming animals and man is, however, based on a false assumption. The plant, as every other form of life, has only one purpose to perform which is to grow and reproduce itself. In so doing it may or may not assimilate the several nutrient elements in ratios that are equally well suited to animals and man. The fact that plants differ so greatly in their requirements, and therefore in their content of nutrient elements, depending on their species or strain of plants, the constantly varying nutrient status of soils, and the fertilizers supplied, the kind of weather that prevailed during the growing season, is sufficient indication that the likelihood of any one plant being ideally suited to supply animal and human needs is extremely remote. Each form of life is a biologic entity, carrying within itself the forces to grow and reproduce when the necessary food is at its disposal. Soil composition, feed and food composition are separate subjects.

HEALTH FROM THE SOIL UP. This theory has called for much praise and acceptance, but is vulnerable. It should more properly be examined in reverse, viz:

HEALTH FROM THE REQUIREMENTS OF MAN AND THE HIGHER ANIMALS DOWN to a multitude of sources, wherever located, is more appropriate. Animals feeding on vegetable matter, the herbivora, may secure their nutrient requirements via plants from soil providing that soil contains them, and crops are grown that assimilate them. But man and the other omnivora that can live on food from any and all sources, require for their optimum growth and health many nutrients that can best be obtained from geologic, atmospheric, marine, animal and microbic sources, and only partly from vegetation. All of these require to be studied. The intestinal microflora of animals and man is analogous with the microflora in the upper four inches of our topsoils, and both depend on inorganic materials for a substrate. For professional and economic reasons there are interests that study disease, but the incentives for organized studies the causes of good health have yet to come. To begin with the problem would seem to involve the following:

1) to ascertain the biochemical composition of animals and humans in good health in comparison with those that are diseased or die naturely. Their difference may be ascertained by analytical methods, and the causes evaluated.
2) to make a life cycle study of the nutrient composition of foods consumed, and the fractions thereof retained by healthy bodies, again in comparison with those consumed by persons that die of disease, or prematurely.
3) since the destiny of all life is death, either deliberately as in the case of animals raised for food, violently or normally, post mortem examinations may be conducted with a view to evaluating the effect of food and feed consumed in body composition if possible.
4) meantime a program may be initiated to amend all soils with fertilizer additions of whatever may be required to make them fertile. All feeds may be supplemented to suit the needs of animals for optimum health and production. That this is possible in the case of dairy cows is currently demonstrated in New York State by a Nutritionist in Batavia, N. Y., George A. Kastner, who has developed a method of testing milk for solids that enables him to determine the need of the cow that gives it and its feed supply for the essential nutrients that may be deficient. Such a method can to advantage be followed on a national scale. All food may likewise be supplemented with whatever deficiencies appear compared with the requirements of humans for optimum health. All amendments whether to soils, to feeds or foods must be designed to benefit the plant, animal or man. A popular demand for refined and devitalized foods that is the result of lack of physical work, or from concepts of superior living greatly

fostered by powerful advertising, cannot very well be blamed on worn out soils, fertilizers, etc., but constitutes hazards of civilization.

5) Nature works as intelligently with pathogens and parasites as it does with man or other of their hosts. Thus elements that are invariably essential to all forms of life are needed by all, and only the dosage determines what is toxic. Thus the higher forms of life require some essential elements in concentrations that are toxic to disease germs in order to benefit their hosts.

What Is Soil?

Soil components may be broadly classified into four parts, viz:

1) THE MINERAL PART OF SOIL. On an average 96% of the dry topsoil consists of mineral matter. These are fragments of rocks in various stages of disintegration, decomposition and combinations. Minerals are chemical compounds formed by nature.

2) SOIL ORGANIC MATTER. This accounts on an average for the 4% of dried topsoil, and is generally in an active state of decay. It is a rather transitory soil constituent, because it readily succumbs to the attack by micro-organisms which are really part of the soil organic structure. In hot climates the soil organic matter is readily used up through oxidation. In humid regions soil organic matter can form acids through fermentation, that are known as humic acids. When combined with mineral particles they form so-called soil humates, also called soil colloids. Virgin soils were so formed by nature, and they owe their high degree of fertility to a combination of mineral-organic matter. The light absorption capacity, the electrolytic sensitivity also called the base-exchange capacity, the fixation of clays all depend on the composition of soil humates. They are subject to as great variations as there are soil-mineral and soil-organic matter that have formed combinations.

3) SOIL WATER. This differs greatly from ordinary river or well water as we know it, because it carries many soluble salts, and therefore may be called the blood of the soil. Soil water can be both beneficial and harmful: beneficial to irrigate soils harmful to leach from soils critical plant foods such as calcium, potassium, magnesium, etc.

4) SOIL AIR. This too differs materially from the air we breathe, and it consists laregly of nitrogen, oxygen, and carbon dioxide. The proportion of these varies with the amount of water present, and carbon dioxide is especially dynamic. Good soils must be well aerated. When air cannot reach plant roots, soils become unproductive even though they contain all essential plant nutrients.

Volume composition of silty loam, when in good condition for plant growth contains approximately 50% solids and 50% pore space. And the solids can again be divided roughly into:

45% to 48% mineral matter) 50%
2% to 5% organic matter)

The 50% pore space under optimum moisture conditions, contains about:

30% space for soil water
20% space for soil air

These proportions are subject to great fluctuations according to the soil's origin, the weather and climatic factors, particularly droughts and floods. Acid soils require neutralizing with lime or magnesium, wet soils drainage, and tillage must be constantly improved.

Soil as the Basis for Agriculture as an Industry, as Well as for Gardening

The reason soil can support plant life physically and chemically is directly due to the fact that the four main soil components exist in finely divided, and intimately related conditions, enabling very complex reactions to occur with surprising ease and rapidity within and between these groups. Contact reactions also called interface reactions are especially important. In this many of the so-called trace elements, the metals, function as donors and receptors of electrical impulses, each at a specific wave length and frequency. The introduction into, or the withholding from soils of any one essential element affects the functions and performance of all others. All are alike important for their pan-dynamic actions, though the quantity of any one may be small is relation to that of another.

It does not suffice merely to supply plants with their nutritional elements; a correct fertilization program must also take care of the *maintenance and improvement* of soil fertility. To improve soil structure requires suitable organic matter; but to supply nutrients to growing plants requires ions of inorganic elements which may be furnished as salts, soil particles, insoluble materials, or from the decomposition of organic matter into inorganic elements. Organic fertilizers in themselves can furnish only such amounts and numbers of inorganic ions as compose them. Any deficiency of ions may be corrected by a supply of those that are deficient, from sources that are immaterial. Typical deficiency regions of soils in America have been ascertained and maps are available to depict them. Also soil tests and plant tissue analysis will reveal the need for suitable soil amendments, or for applications of nutritional sprays to foliage. Trunk injections may be administered to trees.

Of the 102 atomic elements now known to make up our planet there are only 9 elements that take up the bulk of soils, viz:

Oxygen, Silicon, Aluminum, Iron, Calcium, Magnesium, Sodium, Potassium, and Hydrogen.

Five more must be mentioned as active elements that come into question for soils and plants, viz:

Carbos, Phosphorus, Sulfur, Chlorine, Nitrogen.

Then come a large number of minor or trace elements that act as catalysts, function in the formation of vitamins and hormones, are activators of enzymes or co-enzymes, inhibitors of pathogens, viz:

Manganese, Boron, Zinc, Copper, Cobalt, Nickel, Molybdenum, Iodine, Vanadium, Fluorine, Arsenic, Lead, Barium, Selenium, Cadmium

and the above total of 29 elements are now regarded as essential to life. There are another ten that may be regarded as variably essential. But since 102 elements compose our lithosphere, hydrosphere, atmosphere it may be assumed that all of them play important roles, indirectly if not directly.

What Is Plant Growth?

It may be called synthesis of organic matter from inorganic ions by sunshine and darkness, heat and cold. It is not merely the assimilation of bioelements from soils, water and air, but rather a conversion of inorganic elements into carbohydrates, proteins, salts, vitamins, hormones, enzymes. The edible portion of plants reflects merely a portion of the

composition of the whole plant. Thus to supply plants only with the essential elements needed by animals and man would be insufficient for total plant growth.

Agricultural objectives are based on economics, and many farmers who grow for market unfortunately buy fertilizers and feeds for price reasons, but aim at ever higher production goals. Food quality of farm products is seldom a matter of policy, and the cycle thus created is something as follows: poorly fertilized soils produce substandard feed and food, deficient in many elements needed by animals and man. For instance crops will grow without either iodine or cobalt, but their consumption will lead to deficiencies of these elements in livestock and humans. Deficient feeds cause disorders and diseases in livestock which are then most likely treated with drugs and vaccines that still further impair their meat quality. The consumption of substandard animal products as foods, even though sterilized by cooking etc. in turn leads to similar deficiency disorders in man. All these consequences are avoidable if soils were fertilized with a view to produce crops of optimum food quality, instead of for quantity yields, and feeds are formulated for the optimum health of livestock instead of for forced quantity production for market at the least cost of feed. Foods too should be consumed on specifications for optimum human health, and these in terms of nutrient values would at the same time be most economical. As far as the inorganic side of life is concerned a proper nutritional balance may be achieved with inorganic compounds that can be added to soils for plants, to feeds for livestock and to foods for humans. In due course the organic composition of these would automatically balance itself. This is not possible with "organic fertilizers," "organically grown" or "natural foods" for lack of knowledge of their elemental composition, and for the specific need of certain crops. For instance such crops as alfalfa, apples, beets, turnips, clover need boron in concentrations that would be harmful to peas and beans. Since no such differentiations are possible with organic fertilizers it can be seen that specific amounts of boron fertilizers are called for as inorganic boron compounds.

By the end of World War I some 45 different inorganic elements were known to be in plants of various kinds. Only ten of them were at that time considered plant nutrients, viz:

Carbon, Hydrogen, Oxygen, Nitrogen, Potassium, Phosphorus, Iron, Magnesium, Calcium, Sodium, Sulfur.

Most of the others were regarded impurities, accidentally taken up by plants, that required removal by refining, processing, cooking, etc. to make them "pure," perhaps white in color, as marks of quality and civilization for human use. What is now the FDA was then the administration of the "PURE FOOD AND DRUG ACT." From that viewpoint white sugar was held up as the ultimate in food refining, to the envy of other food processors. Common white sugar is an almost ideal processed food: it is cheap, clean, white, portable, imperishable, unadulterable, germ free, highly nutritious, altogether digestible, requires no cooking, and leaves no residue. Its only fault is its perfection. It is so pure man cannot live on it. No wonder that processors of other staple foods tried to develop them along such pattern, such as for instances white bleached flour, bread, margarine, hydrogenated fats, refined vegetable oils, cereals, dairy products, beverages, preserved and canned fruits and vegetables, etc. Elements formerly regarded as impurities are now known to perform specific physiological functions in plants and animal bodies, and efforts are made to restore them artificially, and to "enrich" processed foods with them. The proper method of course would be to leave them in foods to begin with.

At present some 65 elements have been demonstrated to be present in soils and 58 of these in plants. But nowhere are that many present in one soil in one place or in one plant or animal specie. Since we are concerned with indirect nutritional effects, many of them catalytic, one cannot evaluate solely the chemical composition of plants in direct relation to their food and feed value, other than to assume that healthy plants furnish the best food values for the higher forms of life.

The terms "naturally grown" or "organically grown" foods require explanations and they defy nutrient specifications. All growth is natural, and only germ life can grow in an organic medium. The words "natural" and "organic" are lending themselves to propaganda of foods that are anything but of high quality. The health of plants, and animal products determines their food value, and the objects should be the prevention of deficiency diseases both in food plants, and animals whose products are used for food. No milk from diseased cows, no meat from diseased animals, fruits and vegetables, from well fertilized plants, bread from whole grains of the highest grades; these are all objectives that would result in the greatest nutritional benefits and economic advantages for growers and consumers alike.

Human Nutrition

This may be called synthesis of protoplasm, proteins, bones, blood, and other human tissues and substances from carbohydrates, and other plant and animal material, as well as atmospheric, geologic, marine materials with the aid of intestinal micro organisms, light and water. Carbohydrates constitute the bulk of vegetation, but are only a minor constituent in human bodies. Man's ability to think and convey thoughts and experiences to each other and to succeeding generations distinguishes his nutrient requirements. Mental acuity in particular has been related to a group of trace elements such as manganese, copper, cobalt, zinc, magnesium, iodine to which recently cadmium, molybdenum, and selenium have been added. On the other hand man's ever greater consumption of "dead" i.e., processed foods, may place him from a parasite that lives on living bodies, into the category of a "saprophite" an organism that lives on dead organic matter, with consequences unkown on future generations. The greater use of industrial and food processing equipment, of organic pesticides, even the detergents now dumped into rivers and lakes, etc. may impart to our foodstuffs, to our water supply, and to the air we breathe many undesirable impurities and residues. As far as the metallic contaminants are concerned they may be readily detected by the spectroscope, as is also the case with the beneficial inorganic bioelements. Since in all cases the dosage determines what is toxic or beneficial the tolerance in such elements as quicksilver, thallium, arsenic, lead, nickel, selenium, molybdenum is extremely narrow and requires constant control. On the other hand man and the higher animals show great resistance to abuses, and quick response to treatment when on a high plane of nutrition. The minor or trace elements are not harmful and function best when all major elements are adequately present in

the animal and human bodies and their food supply along with carbohydrates, proteins, and fats.

As stated earlier human nutrition should be considered from the requirements of man in optimum health down to their sources wherever located. Soils and plants are merely two, though important sources. *THE PROBLEM OF NOURISHING HUMANS BEGINS WITH FEEDING THE INFANT AND HIS PRENATAL CARE.* Soils play no direct role therein. The human foetus is a sodium organism but upon birth requires for its growth and development enzymes that can only be activated by potassium, magnesium, iodine, copper and other trace elements. Hydrochloric acid is necessary to assure the formation of hemin in the hemoglobin molecule. Unless these are adequately present in the colostrum and the infant is nursed till weaning age, it becomes necessary to supply them as inorganic nutrient materials. This is easily possible with inorganic food supplements of the right specifications; natural foods cannot be relied upon to contain them. When proverbially "healthy people" are held up as examples it should be borne in mind that as infants they were probably nursed by their mothers for a year or longer. The Hunzas, the Bulgarian, Russian, and Tibetan peasants who are known for their good health and longevity, do not practice commercial agriculture. They export nothing in the way of foods, do not use them for industrial purposes, nor dispose of wastes through sewage systems; everything grown is returned to the soil, except what is retained by the animal and human body and even these return eventually. Any excess production of milk is preserved as yogurt or cheese, vegetables are pickled, fruits are dried or their juice fermented, grain is used whole or milled without extraction. But unless simple sanitary conditions are effective, epidemics of infectious diseases occur such as smallpox and typhoid. Many of their soils are low in organic matter, so that organic fertilizers and as a matter of fact any kind of fertilizers are no criteriae, but rock particles washed down the mountain sides, or otherwise accumulated through the ages supply abundant fertility. High altitudes have the advantage of ultraviolet rays that do not penetrate forests and foggy valleys, nor are disease carrying insects, mosquitos, etc., found there. In all these ways such local conditions are not replicable everywhere. But there are many octogenarians, even centenarians in this country in good health and possessed of all their faculties whose nutritional and other habits can be studied with a view to copying them.

By the time degenerative and so-called deficiency diseases manifest themselves much damage has already been incurred that can no longer be corrected with "natural," "organically grown" or other foods. Improper living and faulty diet constitute a lifelong preparation for such troubles as cancer, polio, muscular dystrophy, diabetes, epilepsy, multiple sclerosis, heart troubles, arthritis, not to mention the invasion of pathogens. They then require medical attention. To conquer these disorders they must be prevented, and to prevent them the causes must be known. More and more doctors become interested in the nutritional approach of combatting what are known as deficiency diseases, and an important literature exists on that subject, reviewing and describing the functions of elements now regarded essential to life. Molybdenum, cadmium, and selenium are now found to play essential roles in micro amounts; zinc and boron have recently been found to be necessary in larger amounts than thought adequate. Fluorine, bromine, arsenic, lead, barium, strontium and vanadium have physiological significance ascribed to them. All essential inorganic bioelements play roles either as precursors, activators, coproducts of proteins,—vitamins,—hormones,—enzymes,—the last three of which may be regarded as one family.

Biochemistry is the new science of Nutrition, the study of the chemistry of life. It is the search for an understanding of the chemical reactions which make up the living process. In the present scientific era it is beginning to be possible to explain biological phenomena in terms of molecules reacting with molecules, and thus a new science may be ushered in as "*Molecular Biology*." Meantime for practical purposes these principles stand out:

1) When a disease or disorder is the result of the absence or insufficient presence of an essential element, nothing but a supply of the element in question will help correct it.
2) A product designed to prevent a cause will always, sooner or later replace products designed to merely neutralize or counteract symptoms or effects.

No one is further removed from biological processes than his own body, his garden, or domestic animals, so that everyone has the opportunity to experiment with the nutrients in the food supply.

Before World War II discoveries and inventions were mainly the work of individual great scientists. The complexities of the rocket, jet, and electronic age forced research to be done as the teamwork of many scientists and the cooperation of many sciences, each catalysing and promoting the work of other scientists in other branches of knowledge all based on the principles of an exact science. It will undoubtedly be found that Nutrition, Health, Biochemistry and now "Molecular Biology" are no exceptions, so that progress in the causes of health depends on the cooperation of all who are interested.

Since the destiny of all life is death, undertakers and abattoirs can best report the chemical composition of the dead, so that differences between normal and diseased bodies may be evaluated as to possible nutritional causes in the retrospect. Nothing is ever invented or discovered except by observation and reflection. Controversies can best be dealt with by trying what is advocated by different sides and following the one found correct. In that manner propaganda may be distinguished from facts. Foods, irrespective of source are only as nutritious as the nutrients of which they are composed, and these vary constantly. But the requirements for optimum human health are constant, have always been so, will forever remain so. To balance them calls for careful food supplementation at all times for all ages; and because this can be done there should be no cause for alarm over our food supply for the increasing population of the world, except for man's own ignorance of his needs for good health, and how to produce them.

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The Papyrus Ebers

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The Papyrus Ebers is one of the significant documents in the history of medicine and science.

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Introduction

Within a land area less than one half the size of the Soviet Union, in the countries bordering the eastern Mediterranean Sea, civilization first rose on this planet. From small, wandering tribes, a people progressed into settlements of villages, then cities, until the Egyptian nation was evolved, one of the greatest in the world, and lasting so long that it was ancient even to its later generations. Its achievements were monumental, its wisdom so profound, that in the course of its history it has left to posterity a yet uncounted wealth to nourish and enhance later civilizations.[1] We can still behold its splendor, and know, through the reconstruction of its physical aspects and written records, that mysterious civilization. The unravelers of these mysteries are the archeologists, or more specifically, Egyptologists.

One such man was Georg Moritz Ebers, an Egyptologist and writer born in Berlin, Germany, in 1837. He taught intermittently at Jena anl the University of Leipzig, between expeditions to Egypt. While at Thebes in 1873, he was offered a package by an Egyptian from Luxor who believed it to be of great antiquity. It was a metal case, and inside, wrapped in old mummy cloths, was a huge scroll of papyrus in a perfect state of preservation. It had been found fourteen years previously between the legs of a mummy in a tomb at El Assassif, near Thebes. Ebers deposited his treasure in the library of the University of Leipzig.

On the back of the scroll was a calendar which at the very latest indicated a date a thousand years before Christ. But the exact interpretation of this calendar was not easy. If the origin of the tomb had been known, it would have been easy to date, but the finder of the scroll had died, and with him that knowledge.

For three years, Ebers' work on the dating of the papyrus continued, until in 1875 he was to declare "with probability bordering on certainty" that the papyrus dated from the years 1553–1550 B.C. This dating was later to be confirmed by others such as Ehrmann of Berlin and Griffith of Oxford, both of whom identified the king in whose reign it was used as Amen-Hotep I.[2] Furthermore, texts in the Old Testament seem to coincide most accurately in medical lore with the Papyrus Ebers. The medical lore in the Five Books of Moses was influenced both in language and subject matter by Egypt. As emphasized by Professor Bryan, "These writings could not have been compiled at any time other than that of the Exodus, and the medical information in the Old Testament is essentially identical with that of the Papyrus Ebers."[3] An example which clearly parallels the style of the papyrus is found in Exodus 30:25:

> The Lord commanded Moses to take myrrh, sweet cinnamon, sweet calamus, and olive oil and to make it a holy ointment compounded after the art of the apothecary, it shall be a holy anointing oil.[4]

The translation of the papyrus was made by Ebers and others. Since it was written in priestly or hieratic script, it was necessary to translate the hieratic into hieroglyphic in order to use the Rosetta Stone as a guide, for hieratic was not translatable. From hieratic to hieroglyphic, then to Greek, Ebers finally arrived at a vantage point wherein Greek could be translated into German. Ebers completed this task in less than three years.

While Ebers worked on the translation, the papyrus underwent a complete renovation. The long continuous scroll was carefully cut into pages and bound, thus assuring its preservation and accessibility without danger of destruction

But Ebers was later to claim more fame for his papyrus. He believed it to be one of the "Hermatic Books," known to the Egyptians as the "Sacred Books of Thoth" and purported to contain the sum of human knowledge in forty-two books. Book Forty, the "Book of Remedies," which Ebers is believed to have rediscovered. His claims were challenged, but they are yet to be refuted by new archeological finds.

Historical Background

The era of the Papyrus Ebers began the third great chapter in the history of Egypt, the beginning of the New Kingdom, the Imperial Age, Egypt's emergence as a world power. In 1580 B.C. began the XVIII dynasty of pharaohs who began to rebuild the remains of a once united Egypt, making their capital at Thebes. Now Egypt was no longer an isolated and invulnerable land. Five centuries before, the Hittites, the tribes of the Euphrates, the Phoenicians, the Hebrews, the Hyksos, and other aliens began to nibble at its borders until Egypt was overrun and threatened with assimilation and destruction. Political and religious stagnancy had choked any large-scale retaliation, and Egypt lay docilely undefended while great hordes of aliens annexed her rich lands. Complete conquest was frustrated by the intermittent rise to power of a pharaoh strong enough to offer defense, but no united Egypt existed to clear them out completely. About the middle of the sixteenth century, a family of Theban princes from Upper Egypt managed to unite the people, and the invaders began to retreat.

The first great Pharaoh of the XVIII dynasty of Thebes was Amen-Hotep I, the first Egyptian to make his country's power felt east of the Mediterranean, beginning a period of Asian conquests. The Egyptians became masters of the region extending from the Euphrates to Ethiopia.[5]

In the reign of Amen-Hotep I, from 1557 B.C. to 1547 B.C., the mass of the people seems to have lived as their ancestors had lived in the time of the Pyramids. In the

tombs of the XVIII dynasty there are paintings almost the same as in the pyramids of a thousand years earlier, and the same text appears, sanctified by the tradition of two thousand years.[6]

Prior to the New Kingdom, the people enjoyed a serene and simple good life. The main diet of the common class had been bread, vegetables, fruits, and beer. But now that the new trade routes carried ever abundant new foods and spices, the commoners were able to have a larger, more varied diet. A middle class grew up, nurtured by occupation of the newly-conquered lands, and Egyptian culture was further complicated by many new customs.

With luxury came the illnesses of easy living and the new diseases from foreign lands. Dental caries, extremely rare before the Pyramid Age, became common. It started with the nobility, then filtered into the wealthy classes, then the middle classes and the common people. At every subsequent period of Egyptian history, one finds the same wide prevalence of every form of dental disease among the wealthy who indulge in luxurious diets and the relative immunity among the poorer classes.

Other ailments diagnosed in the Papyrus Ebers are stomach disorders, alimentary and urinary tract diseases, ulcers, constipation, indigestion, disorderly action of the heart, and others. To be sure, these ailments were not new, yet in these times they occurred in greater frequency.[7] Nor were the Egyptians, as a whole, unhealthy, for from Herodotus we see that:

> . . . for three successive days in each month they purge, hunting after health with emetics and cysters, and they think that all the diseases which exist are produced in man by the food on which they live, for the Egyptians are from other causes also the most healthy of all men next after the Libyans.[8]

Religious Influence

The religion in the era of the Papyrus Ebers was a complex theological system of gods and goddesses, the most prominent being Re or Amen-re, the sun god. The Egyptians never evolved a coherent system of religious thought. From the time of Menes in 3400 B.C., gods rose and fell in power as political dominance shifted from city to city. The Egyptian mentality was able to embrace concepts actually in conflict and regard them as compatible.[9] The religion was one of nature worship; the sun was the creator, not of the whole universe, but of specific parts which later begat of each other the secondary components of creation.

In every phase of Egyptian culture, religion was the predominant influence, permeating the entire civil structure, the customs, the arts, politics, and morality of the people, and integrated into the lives of all. As in all other phases of Egyption culture, the art of healing was guided and shaped by the religion. In the medical papyri of the times, rational observations of disease are seen to be intertwined with religious beliefs and magic. Diseases were accurately diagnosed, yet explained in terms not of actual cause but by the presence of beings or spirits entered into the body in food, through a wound or through the vulnerable weak spot of all mortals, the left ear.

To a primitive people lacking any great store of knowledge, it was natural to assume that rational systems of dealing with the unknown could be formulated and simply explained through their accumulated knowledge. All sorts of devices that seemed rational and justifiable to them were created to cope with diseases.[10]

An example of this way of thinking is clearly illustrated by the discovery of the mummified remains of a child whose stomach contained the remains of mice, skinned and eaten just before death. After the inundation of the Nile, when the mud deposited became dried, it was observed that mice emerged from the cracks. This created the belief that these mice were born from the mud and represented the very essence of the life-giving virtues of the Nile itself. Hence, mice were regarded as potent remedies for the preservation of life in desperate circumstances. The practice was devised on rational grounds, becoming magical only when the use of mice as drugs was proved invalid, and this was only in quite recent times.[11]

During the reign of Amen-Hotep I, medicine remained in the hands of the priesthood. The priest was physician and pharmacist, highly respected and, at times, feared by both Pharaoh and commoner, for he held in his hands the power of the gods and the lives of the people. The real power of Egypt was its priesthood, and many were the times when Pharaoh was just another subject.

The temples served as hospitals where the sick were brought nearer the gods, and where sanctified, secluded chambers served as laboratories in which were compounded the elixirs of life, the incense, and where the handservants received the sacred rites from the gods. These were the first known pharmacies, stocked with the old drugs and primitive tools which were the prototypes of our modern manufacturing equipment, brewing vats, mortars, even crude suppository molds.[12]

The Egyptians had no great knowledge of anatomy, since through their firm belief in resurrection the body was considered sacred and could not be dissected. But the Egyptians did perform minor surgery, and they did set broken bones. They knew of the circulation of the blood, the working of the vessels and the heart, and of the lungs. The major source of information for the priests was supplied through observation and experimentation with drugs. Nearly all ancient writers acknowledge the supremacy of Egypt in medicine as illustrated by Homer in the *Odyssey:*

> For Egypt teems with drugs . . . which, mingled with the drink are good, and many of baneful juice . . . There, every man in skill medicinal excells, for they are sons of Paeon all.[13]

The priests began from earliest times to record their cases by dictating them to scribes who wrote them in hieratic script. It is probably in this manner that the Papyrus Ebers came into being sometime around 1550 B.C.

The Papyrus and Its Contents

The period of use of the Papyrus cannot be accurately formulated, since the tomb in which it was buried has never been found. References from the Old Testament are seen to match almost identically with contents of the papyrus, thus proving it was in use at the time of the Exodus, two

hundred years later. Since the papyrus was found to be in a fair state of preservation, it becomes rather difficult to explain the fact that it was used for two hundred years and yet remained unmarked and new. It is assumed by many that upon being entombed, a new and exact copy was made to take its place. This is not unacceptable, since it was common practice.

However, the real value of the Papyrus Ebers is not damaged by the fact that it is a copy of an earlier papyrus, nor does it rest on the claim that it is the sole survivor of the "Hermatic Books," but that

> it surpasses in importance all other medical papyri in the richness of its content and its completeness and perfection. It is the largest, the most beautifully written, and the best preservel of all the medical papyri.[14]

The Papyrus Ebers was written by a scribe, a man specially trained in the art of hieratic writing, one versed in religion, and trained probably as a minor priest. His education had taught him to write at the speed of normal speech and to copy by sight large tracts of text, and he must have been highly skilled artistically to produce such a document.

In appearance, the scroll, as seen by Ebers, was one long roll, twelve inches in width, sixty-eight feet in length. It was divided into pages, each of equal size and with twenty lines apiece, and the number of pages was 108.

The text was written in black ink, made of oil and crushed charcoal, and the headings, the doses, and the directions were in red. Also in red were the rubrics and the capitals of each word starting a new chapter or paragraph.[15]

The whole text was written in hieratic, the priestly script. In reality, it was a corrupted form of the hieroglyphics seen in the ancient tombs and on the obilisks. At first, the fine points of hieroglyphics were slurred over, unconsciously perhaps, then it was a matter of time before the fact was realized that a new and faster method of writing, a flowing, cursive style, could be had if this simplification of hieroglyphics continued. The evolution must have covered a large period, but by the time of the Papyrus Ebers, the art of hieratics had been mastered. It became the script of the priesthood, thus of the medical profession as well. Also, hieratics, like hieroglyphics, could be written from left to right or from right to left, starting either from top or bottom.[16]

The script of the Papyrus Ebers is one of continuous lines of abstract characters flowing together without breaks except after line twenty, when a new page is begun. The text reads from right to left, and doses and drugs, directions and incantations all follow each other with no punctuation to indicate the beginnings of new concepts. Separate prescriptions cannot be identified, for the drugs are not set up one beneath the other.

The contents of the Papyrus Ebers were found to contain 811 prescriptions and more than 700 drugs. It is an encyclopedia of the medical knowledge of the times and describes most of the diseases we know today with enough accuracy for recognition by modern diagnosticians. Many of the contents cannot be identified, since they are disguised under fanciful, contemporary names, their meanings being unknown to present-day Egyptologists. For example, squill was called "Eye of Typhoon," and saffron, "Blood of Thoth."[17]

Many of the drugs used in Papyrus Ebers are still used today, and it is important to note that their use in Egypt was for the treatment of the same illnesses for which we use them today. The drugs were mineral, plant, and animal in nature, and practically every part of the specimen was used.

Among the minerals used were alabaster, an old book cooked in oil, clay from a gate, honey, copper rust, leather from sandals, myrrh, castor oil, oil of the earth (petroleum?), salt, stones, wax, yeast, yeast of the opium drink, collyrium, cake, fermenting bread, antimony, indigo, saltpetre, and others.

The plants used include the acanthus tree, all seeds, caraway, cucumber, flax, garlic, mint, onions, aloes, balsam, barley plant, rotted cereals, coriander, crocus, ebony wood, fennel, linseed, poppy seeds, watermelon, saffron, wheat, gruel, turpentine, herbs, algae, molds, saps, and many others.

Drugs were also made from such animals as the lion, ox, hippopotamus, crocodile, cow, mouse, tortoise, vulture, stag, swallow, ass, dog, cat, frog, crab, locust, beetle, bat, fly, wasp, and others, and from every part of the animal, including the hair, feathers, eyes, ears, brains, blood, bile, marrow, guts, uterus, fat, excrement, and milk.

Many of the drugs on the list are just variations of the main drug listed, such as salt from Upper Egypt, Lower Egypt, or the Highlands, each type supposed to retain different curative properties.[18]

Ailments and Their Treatment

The hot climate of Egypt, the lack of sanitation, the wide prevalence of plagues and leprosy all caused many physical disorders and diseases. Some of the ailments that occurred were cancer, dysentery, tapeworm and hookworm, tumors of all kinds, boils, ulcers, as well as headaches, constipation, and dental aches.

The Papyrus Ebers was divided into sections which dealt with specific regions of the body. Prescriptions were seen in groups meant for use in treatment in diseases of men, diseases of women, diseases of children, diseases of the alimentary tract, of the skin, the eyes, the ear, the nose and the mouth.

Then there were the groups of prescriptions classified for use in the internal parts of the body. They treated such diseases as those of the nervous system, the respiratory tract, and the heart and circulatory system. Interspersed throughout the document were cosmetic hints and preparations, and a chapter dealing with minor surgery, very minor indeed, since it went only skin deep and no further.[19]

Then there were treatments for illnesses whose names cannot be translated. These are the AAA disease, the Met diseases, and the uXedu disease. It is thought that the AAA disease is really a certain stage in the hookworm illness, since this was, and still is today, very common in Egypt. The Met is believed to be the circulatory system or the nervous system. Many prescriptions are given for the treatment of the diseases of this system, such as "remedies to soften the Met, to strengthen and stimulate the Met, reme-

dies for the dried part of the Met, and many more."[20] It seems to have caused no end of worry for the Egyptian priest-doctor. No one even today will venture as to what the uXedu disease is, for so varied and repulsive were the remedies for it.

The prescriptions listed in the Papyrus Ebers were compounded with part fancy and part common sense, and not a little faith was needed to take them. Some were quite simple, only containing one ingredient, such as:

Berries-of-the-castor-oil-tree I

Chew and swallow down with beer in order to clear out all that is in the body.

Others call for great numbers of ingredients, the longest in the papyrus calling for thirty-six different drugs, among which were beans, fruit of the dompalm, onions, splinters of the cedar tree, resin of acanthus, red corn, white oil, goose oil, myrrh, garlic, watermelon, fennel, mineral salt, red lead, natron, and fat of the bullock. It was one of those used "to make the Met supple."[22]

Incantations and rites, rigidly performed to rule, were considered just as important as the use of drugs, since the writing down or uttering of the thought of an act was to be an actual fulfillment of that act. And many times, both drugs and rites or incantations were prescribed for the same patient.

Modes of compounding encompassed all types of physical and even oral preparations. Just to speak certain words held sacred to a drug gave it the needed preparation to make it useful. Compounding methods included boiling, steaming, soaking, crushing, melting, or allowing the drug to rot or ferment. Drugs were mixed together and administered or given separately and allowed to cause their action after mixing within the body. Just to put certain drugs in contact with each other without really mixing them together was believed to give them the necessary preparation to be effective.

Administration of the prescription utilized every orifice of the body to introduce into it the preparation. Suppositories were compounded and were for rectal, vaginal, and urethral use, as well as for ear and nose. Solids and liquids and smoke in the form of burnt incense and drugs, and steam from boiling drugs were used for the orifices. External remedies were also used, taking the form of poultices, washes, plasters, braces and splints (considered remedies in themselves) for injuries of sprains and broken bones, and purifications with incense or smoke. Every region of the body was attacked as sites for external treatment, from the entire trunk to the eyelids, the undersides of the toes, and even the hair.[23]

At times, the treatment of a case seems not enough, as in the remedy for a crocodile bite, where the victim is only instructed to clamp raw meat over the fallen away flesh. Other cases, very trivial, call for the most extreme methods, and are fussed over with exhausting thoroughness.

It is of little use to discuss the therapeutic effects of many of the prescriptions, for very few could have caused anything more than greater discomfort. But yet, in their own day, they were acclaimed as remedies for restoring health, and some as "delightful remedies against death."[24]

But then, to a primitive people willing to undergo the discomforts and humiliations of the remedies of the Papyrus Ebers, the psychological effect is a completely different aspect, and one can imagine in lesser illnesses the speed of natural recovery caused by that principle.

And finally, to justify its beneficial nature, there is the lack of any comment from its own times at to the malignant effects of the remedies contained in the Papyrus Ebers, and the long period of its use is lest proof from the papyrus itself that its remedies prescribed were of service, or its methods would have been discarded.

Conclusion

Today, the Papyrus Ebers is preserved in a bound volume at the University of Leipzig, Berlin, Germany, the University where Ebers taught and where all of the work on the papyrus was done. To create and facilitate new knowledge of this oldest of books, many facsimiles of the original papyrus were produced and distributed to all the major museums and libraries of the world.

Work is still being done to decipher its still many hidden mysteries by Egyptologists in Egypt, Europe, and America.

The Papyrus Ebers has contributed its share to the legacy of Pharmacy in that it added to the profession's background of a full and useful past. Although in Egypt Pharmacy was not recognized as a distinct profession but as a component of the priesthood, today's profession of Pharmacy may point to the Papyrus Ebers as a record of its being one of the world's oldest and evergrowing professions, and one of the most highly respected through all the ages.

The Papyrus Ebers, upon its rediscovery, has brought back to the profession a little more glory to add to its already proud past. And to the members of the Pharmaceutical profession today, it should serve as a reminder of the real purpose and goal of Pharmacy: to search for ever better ways to improve conditions of health, and to perpetuate these improvements for the betterment of man, as has been done through all the past.

NOTES

1 Leonard Cottrell, *The Anvil of Civilization* (New York, 1957), pp. IX–X, introduction.
2 Cyril P. Bryan, *The Papyrus Ebers* (New York, 1931), pp. 1–3.
3 *Ibid.*, p. XVII, introduction.
4 L. E. Warren, "Pharmacy and Medicine in Ancient Egypt," *Journal of the American Pharmaceutical Association*, XX (1931), p. 1070.
5 "Bibliography," *The Volume Library* (Seventh edition, 1955).
6 Leonard Cottrell, *op. cit.*, p. 104.
7 Cyril P. Bryan, *op. cit.*, p. XXIX, introduction.
8 L. E. Warren, *op. cit.*, p. 1073.
9 Leonard Cottrell, *op. cit.*, p. 64.
10 Cyril P. Bryan, *op. cit.*, pp. XVIII–XXI, introduction.
11 *Ibid.*, p. XX, introduction.
12 "Bibliography," *World Scope Encyclopedia* (Fifth edition, 1949).
13 L. E .Warren, *op. cit.*, p. 1075.
14 Cyril P. Bryan, *op. cit.*, p. 5.
15 *Ibid.*, p. 8.
16 Lincoln Barnett, "The Oldest Nation: Egypt," *Life* (Oct. 1, 1956), pp. 96–98.
17 L. E. Warren, *op. cit.*, p. 1072.
18 Cyril P. Bryan, *op. cit.*, pp. 19–36.
19 Cyril P. Bryan, *passim.*
20 L. E. Warren, *op. cit.*, p. 1068.
21 Cyril P. Bryan, *op. cit.*, p. 44.
22 L. E. Warren, *op. cit.*, p. 1068.
23 Bryan, *passim.*
24 *Ibid.*, p. 116.

The Preparation of Programs for the Support of Undergraduate Research in Chemistry

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This paper was presented at the spring meeting of the Pennsylvania Round Table of Science, April 29, 1961, University of Scranton, Scranton, Pennsylvania.

There are a number of foundations which now encourage and support undergraduate research participation programs. The most notable are the National Science Foundation, the Petroleum Research Fund of the American Chemical Society, and Research Corporation. For the small undergraduate colleges desiring to establish an undergraduate research participation program, there is very little excuse for not having support, since these same institutions are the ones to which preference is given. Needless to say, the program should be geared to the facilities of the individual college. There is sufficient variation in the type of support available to allow for this. Information concerning the types of support available is readily obtained from the foundations, together with considerable help and advice in selection and preparation of the programs.

The goals inherent in the supported programs are the further development of undergraduate chemistry majors through direct contact with, and experience in independent scientific research. By use of the scientific method, the exercise of independent thought, and development of the student in *theory* and *technique*, the student will (it is hoped) be stimulated toward graduate work and have an appreciation of what constitutes chemical research. These points emphasize that the students' function must not be that of merely "a pair of hands." These points also have an important bearing on selection of the research problem for investigation.

The selection of the problem for investigation is deemed the most important item of all in a successful proposal for support. The choice should be based upon a) the significance of the investigation, g) the chance for success and c) the ability of the student.

Significance is one of the primary bases for judgment of the proposal; accordingly this as well as some originality is a necessity for qualification as research. The significance is also important toward attainment of the aforementioned goals. The student will realize more satisfaction from completion of work which has significance. The degree of significance is not of as great an importance, for it is difficult for students of this level to judge the degree of significance.

The chances for the success of the research should be quite high in favor of the student. This cannot be assured; however by a thorough literature search, a complete understanding of the area of research and a well designed plan of attack, almost any investigation will yield positive results. It is worthwhile to point out that several preliminary experiments into the feasibility of the outlined approach to the problem not only puts the proposal on more solid ground with respect to its chance for success, but also is viewed very favorably by the granting agency as an indication that support of the project is not money down the drain.

Lastly, the ability of the student must be taken into consideration in selection of a problem. The development of techniques and broad understanding of chemistry is not a rapid process for an undergraduate student. If the project would be difficult for the director who has the experience and background necessary, it would be almost impossible for the student. The high hopes of attainment of the previous mentioned goals, should not be sacrificed for a highly significant project at the hands of an inexperienced undergraduate. The goals, and selection of the problem on the basis of the three points discussed are clearly all mutually dependent.

The actual mechanics of making out the proposal is usually outlined by the supporting agency. Mention might be made however, that the inclusion of any information in favor of the proposal should be included, particularly such things as the director's previous experience with undergraduate research. Also an *adequate* budget should be submitted to cover stipend (fellowship), special chemicals, analyses, breakage, minor equipment, together with any anticipated miscellaneous expenses liable to be incurred on the project.

The success in attainment of the goals in undergraduate research projects on the part of the student, and the director, are truly gratifying and worthy of any effort expended in their preparation.

★ ★ ★

Index of Earth's Plant Life

Details of an International Plant Index, a vast undertaking to catalogue all of the earth's plant life on IBM cards, were revealed this week to taxonomists gathered from all over the world at the Botanical Institute of the University of Genoa.

For many decades botanists have been identifying and naming plant life, but scientists working in different times and places have often attached different names to the same plant. The result has been confusion in the plant kingdom —a situation which the taxonomists of the world would like to remedy.

The taxonomists (whose work is the systematic classification of plants) heard Sydney W. Gould, IPI director, tell how modern data-processing equipment aids the ambitious indexing project, which is supported by a grant from the National Science Foundation in the U. S. The New York

Botanical Garden is one sponsor of the project; another is the Connecticut Agricultural Experiment Station in New Haven, where a roomful of IBM equipment is housed for the cataloguing task. Yale University's IBM 407 is being used for the necessary printing operations.

The automatic compilation will provide one master index of the world's plants (estimated at 1,700,000) by group, family, genus and species names. To accomplish this, it was necessary first to work out a numbering system for coding the scientific names of plants and then to devise a special punched card for recording the coded facts. Each IBM card contains a wealth of botanical information, including the author who first identified the plant and the pertinent details about the publications where he first classified it. Thus, the index will also provide a valuable cross-reference of everything ever written by important authors in botany.

When the huge task of card punching is finished, the index of the plant kingdom will be published in some 50 volumes as a master reference for researchers throughout the world. Mr. Gould envisages a time in the future when additional IBM punched card units will be set up in five branch stations throughout the world—in Western Europe, Asia, South America, South Africa and Australia—to continue indexing as taxonomy progresses.

Thus far, Mr. Gould and the IPI staff have completed 50,000 cards, organizing the plant kingdom down to the group level, and are now working on the next lower order, the genus. From preliminary studies they estimate that the total index of existing publications would take 50 persons ten years to complete without the aid of automatic data-processing equipment. With its help, the work should be finished by a staff of six within five years. Taxonomists in many countries are now helping to gather the data for processing from scattered journals and volumes and manuals of taxonomy.

Before he departed for the Genoa Symposium, Mr. Gould and his staff also had recorded on punched cards the contents of four major European manuals dealing with the flora of France, the Balkans, Scandinavia and Germany.

Work done at the Kew Gardens Herbarium in Britain provides one of the most valuable sources for the International Plant Index. The *Index Kewensis*, started there in 1895 with money donated by Charles Darwin, is a complete worldwide index of flowering plants, covering three sections of the plant kingdom. A supplement published by the Royal Gardens every five years since then has brought the *Index Kewensis* to a total of 13 massive volumes. A cross index of the information in these 13 volumes will be available for the firrst time when the cataloguing job is finished.

The International Plant Index will help not only botanical researchers but nurserymen and amateur gardeners also. It was as an amateur gardener that Mr. Gould first began assigning numbers to plants ten years ago, when he became distressed at the conflicting information he found in botany books. His knowledge of IBM methods provided the key factor for an all-out campaign to clear up the botanical confusion.

NSF Study Shows Scientists, Engineers, and Technicians In State Government Agencies

A pioneer study of state government agencies in all 50 states reveals that almost 41,000 scientists and engineers and 47,000 technicians were employed by these agencies in January, 1959, the National Science Foundation reported today.

Together, the scientists, engineers, and technicians accounted for nearly ten per cent of the more than 915,000 persons employed by the agencies covered in a survey conducted for the Foundation by the Bureau of Labor Statistics of the U. S. Department of Labor.

The survey was conducted in late 1959 and early 1960. It is the first full-scale study of scientific and technical personnel employed by state governments, covering all agencies in all 50 states except those primarily concerned with judicial, legislative, and teaching functions. Returns were received from more than 3,000 agencies.

The more than 28,000 engineers comprised nearly 70 per cent of the total number of scientists and engineers in the state agencies. Nearly 60 per cent of the engineers held college degrees; 45 per cent were licensed or registered as professional engineers.

Of the approximately 12,500 scientists employed, the largest groups consisted of about 3,700 in biological and 3,500 in agricultural specialties. There were about 1,650 medical scientists, 1,300 psychologists, 1,200 chemists, and 600 geologists and geophysicists.

The number of state-employed technicians exceeded the number of scientists and engineers by a ratio of 115 technicians to 100 scientists and engineers. More than 50 per cent of these technicians, or about 24,000, were engineering or physical science aides. In addition, there were approximately 9,300 surveyors, 7,100 draftsmen, and 6,200 technicians in the life sciences.

Nearly 97 per cent of the scientists, engineers, and technicians covered by the survey were employed in three broad agency groupings—public works and highways, health and welfare, and agriculture and conservation. Public works and highway agencies employed 88 per cent of all state-employed engineers and 83 per cent of the technicians. On the other hand, nearly 50 per cent of all scientists were in the agriculture, conservation, and related agencies; approximately 42 per cent were in health, welfare, and related agencies.

Within agriculture and conservation agencies, agricultural and biological scientists accounted for nearly all of the scientific employment. In health and welfare agencies, medical and biological scientists each accounted for about 30 per cent of scientific employment; psychologists accounted for 23 per cent.

The majority of both scientists and engineers were primarily engaged in the operation of agency programs and in carrying out services. Inspection was the second most common function, followed by planning activities. Less than 6 per cent of the scientists and engineers were primarily

engaged in research. Of this group, about 25 per cent were conducting basic research.

Employment of scientists and engineers in the 50 states ranged from 71 in Alaska to 5,310 in California. In addition to California, four states—New York, Massachusetts, Illinois, and Texas—each employed more than 1,500 scientists and engineers in January 1959.

The NSF report on the survey, *Employment of Scientific and Technical Personnel in State Government Agencies,* may be obtained for 45 cents from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

* * *

Girls in Science Here to Stay

KANSAS CITY, MO.—Young women everywhere are taking an increased interest in scientific matters and science careers. Vivid evidence of this zooming trend is on display at the 12th National Science Fair-International, now underway and continuing through Friday at Kansas City's Municipal Auditorium.

The girls are here, in full force. No less than 121 of them comprise 31% of the 385 youthful exhibitors whose projects are on display, competing for more than $4,500 in awards to be made to top finalists.

Like their male neighbors at the exhibits booths here, the girls show a wide range of interests and a diversity of research plans. Their projects range from fairly simple to highly complex, but all have one major factor in common —they clearly show the clever workings of bright, alert young minds whose interests obviously extend beyond dating, TV, fashions, makeup and rock-and-roll idols.

Some cases in point:

Harriet Lievan, 17 year-old farmer's daughter from Aurora, South Dak., checked available reference works, but found no data on how gallstones form in chickens or other fowl. A would-be dietician, she concocted a diet producing gallstones in cockerels. Results, she modestly claims, "could be important in the study of the formation of gallstones."

Judith Cushway, 17, Bakersfield, Calif., experimented with the effects of sound waves on termites. She found two methods effective enough to exterminate a pair of termite types by the directed conductor method.

While Miss Cushway used sound to kill termites, Cecile Leclerc, 16, Berlin, N. H., was employing sound and ultrasound to stimulate plant growth. Sound effects and music, she asserts, upped the growth of her sonics-exposed plants from 33% to 55% over the control group.

Meanwhile, out in Littleton, Colo., 16-year-old Margaret Haberland got interested in a magazine description of some Yugoslav experiments on plants. She injected human red blood corpuscles into begonia stems to show that protein of the blood cells moves upward to the leaves, rather than downward in the stem.

Katherine Krasnow, 17, Suffern, N. Y., believes biology courses can be simplified so the material can be grasped readily by grade-schoolers—without taking a condescending attitude toward the children. To prove her point, she has drafted a biology textbook beamed at the small fry.

Deborah Chase, 15, New York City, offers a tongue-twister of a project called "an inquiry into bacteriophage stimulation of escherichia coli." Her resulting explanation for the stimulation effect of bacterial viruses on single cells, she says, "might serve as an analogy for the run-away cell effect always observed in human and animal cancers."

Contrary to tradition, rats and mice held no terrors for two feminine researchers. Sherry Weihemuller, 16, Fessenden, N. Dak., trained six rats to run a maze and open doors, for which feats they receive suitable rewards. Leslie King, 17, Everett, Wash., showed that mice born with X-ray-damaged brains learned to negotiate a maze at the same rate as normal mice.

Mary Nowicki, 16, German-born Texas resident, is checking the food possibilities of plankton organisms netted from Corpus Christi Bay. Source of her idea, reasonably enough, was a first-hand look at food shortages after World War II during the Berlin blockade.

Vanida Sensathien, 17, of Thonburi, Thailand, wants to help improve the quality and yield of her country's silk output. Her project involves the life cycle of a silkworm and its relation to silk manufacture.

And on the list goes—with just a random sampling indicating that the young male mind has no priority on practical, provocative applications of scientific principles used for the advancement of knowledge and the possible betterment of mankind.

Science Service

* * *

Scientific Research At Academic Institutions

Almost 70,000 of the scientists and engineers at U. S. colleges and universities during 1958—44 per cent of the total—were engaged in research and development, the National Science Foundation reported today.

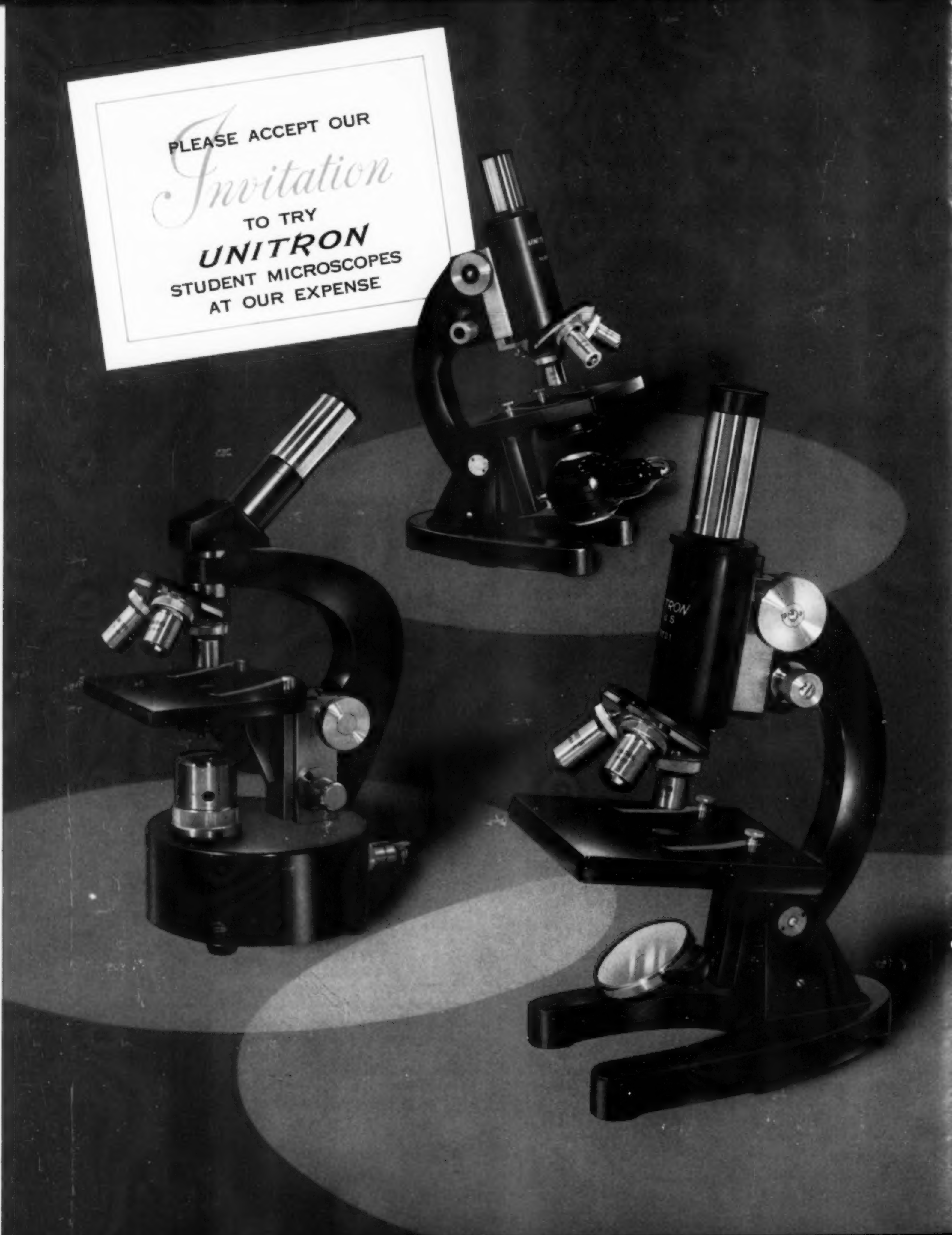
By field of science, the scientists and engineers were employed as follows: in the life sciences, 47 per cent; physical sciences, 26 per cent; engineering sciences, 17 per cent; and social sciences, 10 per cent.

These findings of a survey on the expenditures and manpower resources in research and development in colleges and universities for the year 1958 are announced in *Reviews of Data on Research & Development,* No. 27, "Scientists and Engineers Engaged in Research and Development in Colleges and Universities, 1958," released today.

Between 1954 and 1958, separately budgeted or "earmarked" expenditures for research and development in the natural and social sciences in colleges and universities increased from $410 million to $736 million. The growth of these expenditures necessitated an increase in the number of scientists and engineers engaged in research and development.

To meet the need for additional manpower, universities have apparently allocated more faculty time rather than increase the number of faculty engaged in R&D. The number of faculty engaged in R&D rose by only 3 per cent from 1954 to 1958, while the number of faculty members engaged full-time in R&D rose from about 7,000 to 10,400. Of the

(Continued on Page 58)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WHAT'S THE DIFFERENCE? At first glance, the printed specifications on all student microscopes look the same. You might well ask "What's the difference — if any?" Here are the facts.

Even many of the largest manufacturers feel that optical and mechanical short cuts are quite acceptable in microscopes designed for the school or college laboratory. Therefore, they design their microscopes with lower-resolution objectives, without condensers, and often simplify mechanical construction. In contrast, UNITRON Student Models MUS, MSA, and MLEB are designed to give *regular, professional performance*, with no compromise in image quality.

THE LAWS OF OPTICS HOLD FOR STUDENT MODELS TOO For a beginning student, any enlarged image seen through the microscope will appear exciting. But isn't it just as important to see a *correct* image? A *true* picture? Magnification without resolution is empty . . . the image appears blurred and details are fringed with diffraction lines in much the same way as a faulty TV picture. That's why UNITRON *doesn't offer* a 'student series' of objectives which, though named to imply "achromatic", still let color and aberrations in through the back door. *All* UNITRON Student Microscopes are equipped with the *same professional-type objectives* supplied on our more expensive medical models. Because our high-dry 40X objectives and condensers each have a numerical aperture of 0.65, the student can enjoy the same quality image at 400X or 600X that the medical student sees through his more expensive instrument.

WHY A CONDENSER? In microscopes using 'student series' objectives, the omission of a condenser may not be too serious, *because there is really no high numerical aperture, or resolving power, to be realized.* But all UNITRON Student Microscopes have a *0.65 N.A. condenser* to utilize the *high resolution* of our *professional quality objectives.* We also provide an adjustable iris diaphragm (not merely a disc diaphragm) to control light reaching the condenser. All these extras work hand in hand with UNITRON's anti-reflection coated optics to produce an image of optimum contrast and clarity.

WHAT STAND DO YOU TAKE? Teachers and students want easy operation, durability and adaptability. And that's just what UNITRON Student Microscope Stands are designed to give. Positive and smooth coarse focusing is by a diagonal-cut rack and pinion. A simple counter-twist of the knobs gives easy tension adjustment to meet any preference. A separate and independent fine focus with full range of travel has a precision micrometer screw to assure sharp images.

Now — about the microscope stage. For precise movement of the specimen at 400X and higher, UNITRON offers a quick, easy way of attaching a reasonably priced *mechanical* stage. (Some manufacturers offer this feature — but only on their higher priced models.) All UNITRON Student Microscopes have stages pre-drilled and tapped to permit future addition of a precise, but inexpensive ($14.75) mechanical stage. The large stage of Models MUS and MSA also acts as a bumper, projecting beyond the objectives and nosepiece to prevent accidental damage.

SOMETHING NEW HAS BEEN ADDED. All UNITRON Student Microscopes now have built-in focusing stops that prevent accidental contact between the objective and specimen slide. This reduces repair costs for objectives and prevents slide breakage. Without the stop, it is easy for beginning students *to pass through* the critical point of focus, not even realize it, and ram the objective into the slide. The new stop also saves time and temper by *automatically* placing the image in approximate focus. Student guesswork is eliminated.

NEW 10X WIDE FIELD EYEPIECE Student microscopes are often chosen with at least two eyepieces, usually the Huygens type . . . a 5X for its large area of view, and a 10X for the magnification needed for critical observations. Now, our new coated 10X Wide Field eyepiece *combines* both these features in *one* eyepiece — *a large field and the desirable 10X magnification.* Teachers will like it: one eyepiece is more convenient than two. There's no chance for the extra one to become lost or damaged. And, it's slightly easier to use the Wide Field eyepiece because of its longer eye relief — you don't have to get your eye so close to the lens. Model MUS is now regularly supplied with this new eyepiece, but it's optional on Models MSA and MLEB, too.

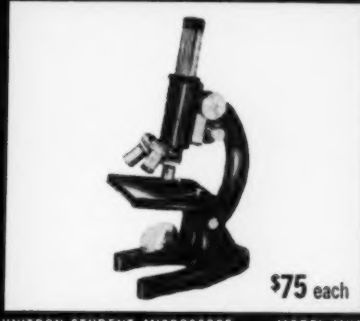
ATTACHABLE SUBSTAGE ILLUMINATOR. A snap-fit illuminator that attaches by means of the regular mirror mount, this new accessory eliminates any need for mirror adjustments or an outside light source. Even when the microscope is moved or inclined, the illuminator stays in alignment. It combines correct light intensity with convenience. Operates on regular 110–115V. current. The housing is rotatable 180° to give a choice of two types of illumination: bull's eye condenser for concentrated light or plane condenser for diffuse lighting. Built-in blue filters give daylight quality. Cost? — only $10 as an accessory (less an allowance for the regular mirror if you don't need it.)

MEETS C.C.S.S.O. REQUIREMENTS . . . AND MORE. UNITRON Student Microscopes more than meet the general requirements outlined in the *Council of Chief State School Officers* Purchase Guide. Our microscopes are available with either three or two objectives. Models with two objectives are supplied with a triple revolving nosepiece (with removable plug in the extra aperture) so that you can add another objective when you want it, without the extra expense of changing nosepieces.

CAN YOU AFFORD NOT TO BUY? Check some of the prices listed in other suppliers' ads and literature . . . then look at ours. UNITRON *saves you real money.* And, if you're in the market for several instruments, new quantity discounts make our prices even lower . . . 10% for 5 to 10 and *even higher discounts on larger quantities!*

WHY NOT TRY ONE? If you are planning to buy microscopes, now or for your next budget, please accept our invitation to try one, or all three, UNITRON Student Models in your own laboratory, at our expense. Let UNITRON prove itself *to you* before you decide.

*Free delivery to your school. Plastic dustcover, fitted wood case with handle and lock, are all included in prices shown. For information on other microscopes and accessories, send for free catalog — see coupon.



UNITRON STUDENT MICROSCOPE . . . . . MODEL MUS

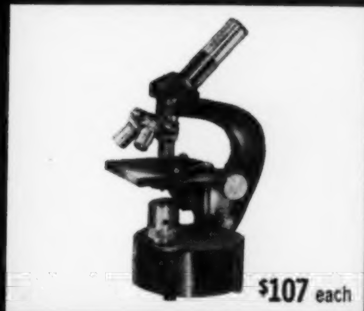
EYEPIECE — Coated 10x Wide Field

OBJECTIVES — Achromatic coated 5x(.10NA), 10x(.25NA), 40x(.65NA)

SUBSTAGE — .65NA condenser, iris and mirror

PRICE* — $75 each (or $67.50 each in lots of 5–10)

With two Huygens eyepieces — choice of 5x, 10x, 15x — price is $74 each, (or $66.60 each in lots of 5–10). Substage illuminator available in place of mirror or as accessory, at slight change in price.



UNITRON AUTO-ILLUMINATION . . . . . . MODEL MSA

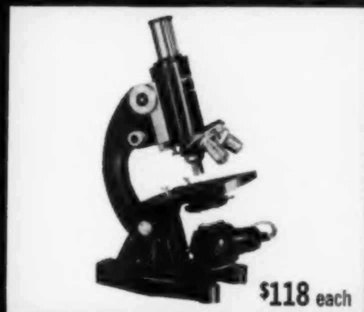
EYEPIECES — Coated Huygens 5x, 10x, 15x.

OBJECTIVES — Achromatic coated 4x(.10NA), 10x(.25NA), 40x(.65NA).

SUBSTAGE — .65NA condenser, iris, filter holder, built-in transformer and high intensity illuminator.

PRICE* — $107 each (or $96.30 each in lots of 5–10).

With 10x Wide Field Eyepiece in place of three Huygens, MSA priced at $103.50 each, (or $93.15 each in lots of 5–10).



UNITRON STUDENT—LABORATORY . . . MODEL MLEB

(illustrated with optional illuminator)

EYEPIECES — Coated Huygens 5x, 10x, 15x.

OBJECTIVES — Achromatic coated 4x(.10NA), 10x(.25NA), 40x(.65NA)

SUBSTAGE — .65NA condenser, iris, filter holder, and mirror

PRICE* — $118 ea. . . . $106.20 ea. in lots of 5–10.

With 10x Wide Field Eyepiece in place of three Huygens, MLEB priced at $114.50 each, (or $103.05 each in lots of 5–10). Substage illuminator available in place of mirror or as an accessory at slight change in price.

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Funds for Science Teaching

More than $108 million—half of it Federal funds—has been used to improve the teaching of science and mathematics in the public elementary and secondary schools during the first two fiscal years of the National Defense Education Act, the U. S. Office of Education said today. The money has been used for acquisition of instructional equipment and materials and for minor remodeling.

The Office of Education said that States have approved 56,545 projects involving science and mathematics under provisions of Title III of the Act. These projects included minor remodeling of 6,211 classrooms and laboratories. The number of secondary school projects slightly exceeded the number of elementary school projects. However, the total cost of science and mathematics projects in the secondary schools is about 25 times the cost of similar projects in the elementary schools.

Size of these projects ranges from less than $100 to more than $50,000. They include such items as microscopes, calculators, slide rules, other special laboratory equipment and audio-visual instructional aids; some projects include planetarium projectors and equipment for teaching astronomy.

States report these trends as a result of this combined Federal, State and local effort to strengthen instruction:

—Newer and advanced concepts of mathematics are being introduced at earlier grade levels.

—Some high schools are adding third and fourth year courses in mathematics.

—There is greater emphasis on laboratory work in which students have opportunities for individual experiments.

—More science instruction is being provided in the elementary schools.

—Many States report enrollments in science and mathematics are going up, in some cases as much as 40 to 50 per cent.

—Advanced chemistry and physics courses are being added to many high school curricula.

In addition to Federal funds for equipment and materials, the Office of Education has paid to the States during the first two-year period $3.4 million for employing science and mathematics supervisors at the State level to develop curriculum guides, demonstrate new materials and equipment, and to help local school instructors improve their science and mathematics programs.

By June 30, 1960, the States employed the equivalent of 153 full-time supervisors. Before the passage of the Act, there were only 27 full-time supervisors in the entire country.

New Books

Physics for the Inquiring Mind

• *By* ERIC M. RODGERS. Princeton University Press. 1961. Pp. 776. $8.50.

As the title implies, for the non-scientist who is interested this is an excellent book to use as a work-your-own-way-through-physics project. It is designed with the thought of helping the individual by studying, experimenting and reasoning to learn the what and why of the subject.

The book is well balanced with a wealth of diagram and problem examples as well as do-it-yourself experiments that endeavor to increase the knowledge and understanding of the subject.

A great deal of pertinent historical information goes hand-in-hand with the subject matter and results in a book not "about" but "in" science as the author himself suggests.

There are five subdivisions:

1) Matter. Motion and Force.

2) Astronomy. A History and Theory.

3) Molecules and Energy.

4) Electricity and Magnetism.

5) Atomic and Nuclear Physics.

There are two interludes, one in arithmetic and the other mathematics and relativity. Even the problems are not the usual plug-into-a-formula type but rather the kind that need and leads to reasoning and logical thinking.

The book has been used by the author as a one-year course in physics at Princeton for undergraduates who are non-science majors. The book treats a series of topics intensively, the topics being chosen to form a good co-ordinated structural view of physics, a development of critical reading ability, reasoning and logical thinking. The mathematical aspects require only a good high school background in algebra and geometry. It is not simply a repeat of the content of a high-school physics course.

Students and teachers alike will find this a worthwhile source book for new ideas that are in line with the present trends in changing the approach to the teaching of physics in this space age.

Andrew J. Kozora
Chairman, Department of Physics
Duquesne University

X-15 Diary

• *By* RICHARD TREGASKIS, E. P. Dutton and Company, Inc. New York. 1961. Pp. 317. $4.95.

In view of the recent performance of the X-15 and its probable future accomplishments, this is a timely book. It is written as a diary and gives an accurate picture not only of the scientific and technical problems encountered in the development of our first "spacecraft," but also an interesting insight into the personalities of the various types of specialists who have worked to make it a success.

The author is an experienced journalist and he is best known for his book *Guadacanal Diary*. In this new book, he presents an account of the X-15 project starting on February 26, 1959 and ending August 15, 1960.

Radioactive Substances

• *By* MARIE CURIE. Philosophical Library, Inc. New York. Pp. 94. 1961. $2.75.

This little book is a translation of the thesis presented to the faculty of science of the Sorbonne by Madame Curie. While the content matter of the thesis is fairly well known to students of science, it makes interesting reading from the standpoint of the history of science and the insight it gives into the methodology of Madame Curie.

There is nothing new in this little book, but we recommend it on the basis of its historical interest.

Paper Back Editions

Harper Torchbooks— The Science Library

Several new and significant titles have been added to this excellent library. Scientists and historians interested in the development and growth of science in the eighteenth century will find A. Wolf's two-volume study, **A History of Science, Technology, and Philosophy in the 18th Century** ($2.50 each), a valuable resource. Each chapter deals with the problems encountered in a single science, and a rather complete index makes the work a convenient reference book. The printing is excellent, and the 769 illustrations add to the appearance and interest of the text.

Three interesting studies in physics which should interest every scientist and philosopher of science have been added to the sreies. **Turning Points in Physics** ($1.45) is a series of lectures given at Oxford in 1958 by R. J. Blin-Stoyle, D. ter Haar, K. Mendelssohn, G. Temple, F. Waismann, and D. H. Wilkenson. The introduction is by A. C. Crombie. This 192-page volume can be recommended to both the specialist and non-specialist. **The Nature of**

Thermodynamics by P. W. Bridgeman ($1.40) is a well known study that many will be glad to see available at a very moderate price. **Causality and Chance in Modern Physics** by David Bohm ($1.35) is an excellent discussion of one of the big problems in modern physics and philosophy.

In mathematics, **The Higher Arithmetic** by H. Davenport ($1.35) and **The Skeleton Key of Mathematics** by D. E. Littlewoid ($1.25) can be strongly recommended to mathematicians interested in number theory and various algebraic theories.

A Modern Introduction to Logic by L. Susan Stebbing ($2.75) is an excellent book on traditional and modern logic and will remain one of the best books in its field for some time to come. It has an excellent index and bibliographical appendix.

Mentor Books

The Individual and the Universe by A. C. B. Lovell ($1.50) is a survey of the advances in astronomy from Galileo to the present. The author is director of the Jodrell Bank Experimental Station in England. His analysis of the origin of the universe and his contrast of the theory of the expanding universe and the steady state theory is sharp, clear, and thought provoking. His view as an individual is that cosmology must be based on both science and metaphysics. This book can be highly recommended not only to those interested in astronomy but also to philosophers and theologians. For an interesting, popular, and accurate account of the atmosphere, its history, composition, behavior, and relationship to man, we can recommend **Our Atmosphere** by Theo Loebsack ($0.50).

Three books related to the biological sciences and to evolution have been added to the list. **A Guide to Earth History** by Richard Carrington ($0.50) is a good popular account of the origin of the earth and man. However, the origin of the Jewish and Christian religions is considered only as an aspect of evolution. **The Forest and Sea** by Marston Bates ($0.50) is an interesting book on the study of life and man's place in nature by an outstanding zoologist, and it can be recommended for the science reading shelf.

Signet Books

How to Know American Marine Shells by R. Tucker Abbott ($0.75) is a handy reference work for those who live or vacation at the seashore. It is divided into two parts: Part I is a discussion of the natural history of sea shells, and Part II is devoted to the identification of the sea shells of the United States and Canada. There are many illustrations and twelve pages of colored plates showing various interesting shells. In addition, there is a geographical index.

Six Days or Forever by Ray Ginger ($0.50) is a good factual account of the famous Scopes trial and the rivalry of William Jennings Bryan and Clarence Darrow.

★ ★ ★

Federal School Subsidy

WASHINGTON—In the forthcoming vote on whether or not to subsidize public schools, Congress actually will be deciding whether to change the course of American history, according to the Chamber of Commerce of the United States.

"Once this kind of a step is taken, there is virtually no hope of ever turning back," the Chamber said. "The consequences are borne by all future Americans.

"Once teachers go onto the federal payroll—and that, in effect, is what would happen—how could they possibly view the world around them otherwise than in terms of central government solutions to all economic and social problems? And how could they help but indoctrinate their students with this same philosophy?

"Then what? Who except a few non-conformists would be left to promote conservatism in the next generation?"

The Chamber's weekly newsletter, Washington Report, in discussing the school subsidy legislation which has been passed by the Senate and is awaiting final action in the House, said: "The decision is at hand in an 80-year drive to clamp the repressive arm of federal bureaucracy around our public schools. The threat has never been as real as now."

The issue, the Chamber said, is not so much over how the schools shall be financed. Rather, it's a matter of "abandoning our children to the centralist idea and leaving the historians among them to wonder what we ever found so attractive all these years about local pride, individual effort and community ingenuity and responsibility, on which our schools now rely."

"The pity of it all is that federal subsidy is not needed," the Chamber said. "There is nothing wrong with the school system that local effort is not overcoming. Without questioning the motives of those pressing the issue, it is a remarkable fact that the subject of federal aid for elementary and secondary schools first came up for action in the 47th Congress, in 1881, and the effort has persisted since, in war and peace, good times and bad. The age of missiles and satellites has added nothing to the arguments for subsidies except just one more excuse."

In alerting its members, the Chamber said that when the indoctrination of school children in the big central government idea begins, the question will be how much longer a businessman will be left free to manage his own business.

From the businessman's standpoint, it's a question of protecting himself—and the successors in his business—from controls over prices, wages and business procedures, from endless bureaucratic red tape, and from unfair tax and labor laws, the Chamber said.

Chamber members were uregd to let their Congressmen know how they feel about this issue, and they were warned: "It's now—or maybe never."

U. S. Chamber of Commerce

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The Operational Aspect

(Continued from Page 36)

ent. For science is first of all an intellectual affair, the data have first to be brought into the sphere of the intelligible. Immediate success in this matter can be obtained most readily with respect to those aspects of reality on which the intellect has, as it were, a direct grip—namely, the mathematical and philosophical aspects. Thus much was left at first out of consideration, at least in the formal sense, for materially speaking nothing remained unconsidered. The reason is that the whole of nature was raised to the level of an intellectual consideration in the philosophy of nature, but this mode of considering was and remained a special kind of intellectual pursuit.

NOTE

[1] *Metaphysics*, bk. 8 (Theta), ch. 9, 1051a 21–33.

It's the Principle of the Matter

• **Nancy E. Gerardi**
DETROIT, MICHIGAN

The fallacy, too much teaching and too little learning, is one into which the good teacher can fall. Only constant evaluation of our teaching methods can help us to avoid it.

The product of good teaching is students who think critically.

In the past few years modern education has been affected by a series of trends or schools of thought which have been influenced by external events which in turn bring about new trends of thought. To illustrate this in more vivid terms, the Russians launched into space their Sputnik I in 1957. It has been recognized as a triumph for Russia, and, indeed, the steppingstone to the heavens. Also with this Soviet achievement came the dawn of the Space Age which, while causing exhilaration to some people in the world, created fear and depression to others. The group of people who perhaps were hit the hardest by the impact of this scientific achievement were those in the United States who are engaged in the teaching profession and, in particular, those who teach science. Immediately scientists began to ask themselves just what had happened in America that it lagged so far behind in scientific accomplishment. They felt the answer could be found in the science education program offered in American schools.

Immediately, cries went up for the schools to enrich their science programs, and people began to compare the educational systems of the United States and Russia. It was found that Russia had a far more concentrated science program in their schools which seemingly appears to be accelerated courses in physics, chemistry, biology, astronomy, languages, and mathematics during the high school years. When this became known, the United States "stepped up" its science programs and attempted further improvement by adding more material to present courses.

But there is far more to this problem than adding material to courses. Enriching the science program quantitatively isn't enough—it is quality that counts. Therefore, after probing the problem more deeply, what must be done in education becomes more apparent if the country wishes to produce scientists of the highest quality.

The underlying principle behind the entire problem of better education and, in particular, science education, is teaching students to think critically. This important thought process is essential if we wish to upgrade the quality of education in our schools today. It is unfortunate that this has been neglected at all levels of our education.

Undeniably, basic facts are important, but one must admit that the application or explanation of these facts is even more important. For example, we all learned on the elementary level that one plus one equals two and two plus two equals four. We also learned the multiplication tables in much the same way. In high school biology we learned that all protozoans belonging to the Class Ciliata have cilia, or that a characteristic of all mammals is a structure called a diaphragm. These facts in themselves mean nothing, but they begin to take on a meaning when the child learns how he got an answer of two or four, and that now if a person gives him one penny and another penny he has two pennies which enable him to buy candy; or the high school student knows that cilia are for locomotion and obtaining food; and that the diaphragm is the most important muscle in the body concerned with breathing. These facts now take on new meaning and usefulness. It should be this way in any course, whether on the elementary, secondary or college level. For the scientist of today, what value is the knowledge that air has pressure if he doesn't know the uses of this air pressure.

But there is one more difficulty involved in this situation —how do we go about teaching the children, regardless of educational level, to apply their knowledge of facts or their principles; in other words, how do we teach them to think critically? Let's look at what has been somewhat neglected by many educators in the field of science today. Strange as it may seem, the answer to the question seems to lie with the college and university professors. These professors must begin to teach students to analyze and synthesize principles rather than teach a number of isolated facts which, at best, results in a good deal of "busy work." If college students are taught this art, they, in turn will teach others to appreciate the true meaning of science and all its implication to mankind. It is imperative, however, that this method of teaching be taught at college level. Frequently, educators are so engaged in the technical aspects of advancement that they forget to teach the basic principles. This is particularly harmful to the student teachers who are frequently asked questions which are basically simple to answer. However, the student teacher is so aware of the technical aspects of work she gets in college and the aggregation of isolated facts given by the various professors, that it shocks her when she cannot answer a question involving a simple basic principle.

It is not advocated that college work should be simplified to a few principles; rather it is proposed that the college or university professor change his teaching method wherein his students are taught to analyze critically and to apply principles to situations rather than situations to principles; that professors do not teach isolated facts inserting unrelated principles, but rather to synthesize the principles and bring out the application of these principles in a coordinated manner.

If more depth of subject matter were imparted to student

teachers, they would not have to go into their profession and "learn all over again." Real learning would take place in our schools and the time spent in reviewing could be devoted to more advanced and interesting projects which students could work with the teachers.

If this process of critical analysis and synthesis becomes a part of our educational process, students at college level could adjust to almost any given teaching situation and phenomenal advances would be made not only in scientific accomplishment but also in the social and economic aspects of American life.

College is supposed to develop the mind; give breadth and depth to our knowledge and teach us to think for ourselves. It should not serve as a place for accumulation of isolated facts which are soon forgotten.

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Seattle 1962

WASHINGTON—May 2 to 5 have been set as the dates for the 13th National Science Fair-International, and Seattle, Wash., has been officially confirmed as the site of the 1962 fair, Dr. Watson Davis, director of Science Service, announced today. The annual event is conducted by Science Service.

The fair dates coincide with Seattle's huge Century 21 exposition, the six-months-long "Space Age World's Fair" scheduled to open April 21. Century 21 officials played a major role in getting the fair to Seattle, Dr. Davis said.

The fair will be conducted on the lower level of Seattle's Civic Auditorium. Approximately 38,000 feet of floor space will be available for the more than 400 student exhibitors expected.

The auditorium is part of the four-blocks-square area devoted to the Century 21 exposition. Fair visitors and entrants will have the opportunity to view exposition highlights, including the $9,000,000 U. S. Science Pavilion, described as "the greatest science exhibit ever assembled for public showing." The Government-supported pavilion is now under construction and slated for completion in mid-February.

G. L. Hollingsworth, director of Boeing Scientific Research Laboratories, Seattle, is chairman of the local planning committee for the national fair.

The 15th National Science Fair-International will be held at Philadelphia in May, 1964. The recommendation was made by the Science Fair Council and affirmed by Science Service during this year's fair at Kansas City, Mo., last month. The 1963 fair is set for Albuquerque, N. Mex.

Science Service

Morton and Anesthetics

• By Eva Adams

SCHOOL OF PHARMACY, DUQUESNE UNIVERSITY, PITTSBURGH, PENNSYLVANIA

The fundamental aim of medical art and science is, and always has been, the alleviation of human pain and suffering. In no field of medical endeavor has this aim been so satisfactorily achieved as in the development of surgical anesthesia. This is not so remarkable in view of the fact that submission to surgical procedures involves the conscious anticipation of pain and distress for greater than that usually realized in accidents or ordinary sickness.

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The development of anesthetics from an empirical form to a firm rational foundation has been one of the greatest achievements of science. Anesthesia may be accomplished in two ways. The bringing about of unconsciousness with general loss of sensation is general anesthesia. On the other hand, the application of the agent to a particular local area of the body, to abolish the sensation of pain in that area, is local anesthesia.

Very little was said about early attempts at anesthesia. At the dawn of civilization very primitive forms of anesthesia were practiced. In the meantime patients submitting to operative procedures underwent indescribable agonies. The most useful form of local anesthetics was application of pressure, as is shown by the Egyptian cravings illustrating the method. Their age was established as that of approximately 2500 B.C. They were discovered on the door-post to a tomb excavated by Loret in the Necropolis of Sagguarah. Among the early Assyrians pressure was used on the blood vessels to give anesthesia.

Some of the Arabian authorities speak of a form of anesthesia by inhalation. This was probably derived from the Chinese, for Hua-T'o, the Hippocrates of China, is said to have taught this practice and "used for the purpose a combination of aconite, datura, and henbane."[1] It was later revived in the thirteenth century, when it was called "soporific sponge."[2]

Local anesthesia has been one of the most important factors in the development of modern highly specialized surgery. References to it occur in the Bible and in Homer. In the *Odyssey* Homer refers to "nepenthe" as a substance "robbing grief and anger"[3] and abolishing all painful memories. This draught has been suspected of containing Indian hemp, a soporific that had probably been previously employed by the Egyptians. Among the most primitive methods of inducing general anesthesia was the stoppage of blood flow to the brain by blocking the carotid arteries by pressure. There are many evidences that the early Chinese and Egyptians were familiar with the pain relieving properties of opium and of Indian hemp. Herodotus gives the first references to inhalation anesthesia when he describes how the Scythians inhaled the fumes from hemp preparations before submitting to surgical operation. A Chinese manuscript has been found which gives the formula for a hemp mixture which when given to patients renders them insensible to pain. The most important of the ancient anesthetic agents was mandragora. Its use was well described by Pedacius Dioscorides, a Greek army surgeon in the service of Nero, 54–68 A.D. Dioscorides is the authoritative source for the materia medica of the ancients. Variations of this mandragora anesthetics of Dioscorides were used in Europe all through the Middle Ages.

The Romans took mandrake in wine to produce narcosis following injury or preceding a surgical operation. The poppy and mandrake, with one or two other plants, remained the only pain-relieving drugs for centuries. The mixtures were often administered by mouth, although the *spongia somnifera* became popular during the Middle Age.

The *U. S. Congress Reports* on the ether discovery contains an account by Meisner of a secret agent given by Weiss to August II (1670–1733), king of Poland, which produced such a perfect state of anesthetic that the king's diseased foot was amputated without his feeling it. In fact the operation was performed without the royal patient's consent, and was not discovered by him until the following morning.

Many factors delayed the coming of potent anesthesia in life; tradition and religious opposition being two of the principal ones. People kept closely an old saying "In sorrow thou shalt bring forth children. . . ." (Genesis 3:16) and for a long time many believed it should remain that way. Although ether was first discovered in the sixteenth century by Valerius Cordus, of Germany, three hundred years passed before its anesthetic properties were recognized.

For thousands of years before that patients who were operated upon suffered the most excruciating pains. Obviously under such conditions, doctors used the knife only in case of emergency, and surgery was limited to a relatively small number of operations that could be performed in a short time because no patient would have stood the torture of a long-drawn surgical intervention. Even such "minor surgery" as tooth extraction was so painful that again and again in history teeth were deliberately pulled as a form of torture or of punishment.

With change of times and nations, the conception of pain and the means of resisting it changed likewise. Rene Tulop-Miller in his work entitled *Triumph over Pain* discusses idea of "mental inertia." In his words:

> . . . 'mental inertia' was handed down in our race from generation to generation, being as old as mankind. To make novelty triumph over this inertia something more is needed than the intuition of genius, than ambition and zeal. Those who would win through must have staying power which will bring them victoriously to the goal; courage which shrinks from no responsibility; resolution which pays no heed to obstacles. . . . He only who combined all these qualities could hope to bestow upon his fellows the boon of anesthesia."[4]

There were many people who attempted to minimize human sufferings. One of them was Henry Hill Hichman, whose sensitive feelings were appalled by the agonies suffered by patients undergoing surgical operations. He

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Image Tube Development Providing Significant Help To Astronomers

A new research tool that is giving astronomers previously unobtainable data may prove to be as great an advance over conventional astronomical photography as photography was over visual observations.

The device is called a photoelectric image intensifier, or image tube. Three recent investigations using image tubes, as well as development of the tubes used in two of these three projects, were sponsored by the National Science Foundation, an independent agency of the Federal Government.

In essence an image tube is an electronic device for amplifying the signal produced by a photon, or light unit—that is, faint light is in effect made brighter. This enables astronomers to observe heavenly objects heretofore too faint to be identified, or to use much shorter exposure times to lessen atmospheric distortion of brighter objects.

These tubes have already increased telescope speeds by as much as 30 times, and have the potential of increasing them by a factor of 100.

Development of image tubes has been carried on by the Carnegie Institution of Washington through the Carnegie Committee on Image Tubes for Telescopes, initially with funds provided by the Carnegie Corporation and more recently under NSF grants totaling $385,000. Two recent investigations have used image tubes from this project.

A third investigation used an image tube called an "electronic camera" developed by A. Lallemand and M. Duchesne of the Paris Observatory with the aid of the French Government. Lallemand is a pioneer in image tube development, and was one of the first to point out the potential advantages of such a device.

Identification of a very dense star cluster at the center of the Andromeda galaxy is an important result of use of the Lallemand tube. Little was previously known about this very small and bright light source except that it usually had the appearance of a star. Lallemand and Duchesne, together with Merle F. Walker of the Lick Observatory, used the electronic camera mounted on the coudé spectrograph of Lick's 120-inch telescope. While with conventional equipment a five to fifteen hour exposure would have been required, they made their two spectroscopic exposures in about 15 and 45 minutes using the image tube.

To state it differently, the 120-inch telescope with image tube obtained results that would have required a 660-inch telescope without the tube.

Because this investigation was conducted in the near ultraviolet region (4000 angstroms) and the lens coat-

ing on the Lallemand tube absorbs ultraviolet, the efficiency gain was 20-25 times rather than the potential of 100 times if used in other regions of the spectrum.

An analysis of the spectroscopic results plus photometric data obtained independently shows that the bright object is apparently a large, dense cluster of stars similar to the well-known globular clusters but very much more massive. It is about 24 light years in radius, whirling at high speed, and contains a mass of stars equal to 10,000,000 times the sun's mass.

If our sun were in the center of the cluster we would see about 10,000 times as many stars in the night sky as we do now, and the total light from them would be greater than the light of the full moon.

The National Science Foundation granted $8,600 for this work. More recently, in June, NSF granted $34,600 to Walker for putting an improved version of the tube into routine use at the Lick Observatory.

A second investigation using an image tube involved recording the infrared lines of the sun's corona. John Firor of the Carnegie Institution and Harold Zirin of the High Altitude Observatory, Boulder, Colo., used the device with the Climax coronagraph of the High Altitude Observatory to record solar infrared lines in about one minute. The first photography of these lines, by Lyot at the Pic du Midi Observatory about two decades ago, required four hours. The fastest film now available would require an exposure in excess of half an hour. The need for the sky to be extremely transparent for this extended period has made earlier attempts most difficult.

Firor and Zirin were able to show, with these and associated observations, that only one temperature need be assigned to any one part of the inner corona to account for the many states of atomic excitation and ionization found there.

The third use of an image tube recorded a third type of observation for which the tubes are extremely useful, that of binary stars. Binary or twin stars revolve around each other. To the naked eye and frequently to telescope observations they appear as one star. Lawrence Frederick at the Lowell Observatory recorded binaries with separations as small as .3 seconds of arc using the image intensifier, while separations of 1.5 seconds of arc are almost impossible to photograph without it.

With the image tube he was able to make exposures at 1/100 second, and record the binary images before atmospheric turbulence distorted them.

This technique should greatly speed up the study of binary systems since the closer systems are also those rotating most rapidly.

In the system used in many image tubes, a photon received through a telescope lens is directed against a photo cathode, giving rise to an electron. The electrons are speeded up by an electrical field, then focused on a phosphor screen. Bombarded by fast-moving electrons, the phosphor screen emits two or more photons for each electron. The light thus produced is collected by a lens and photographed.

In the Lallemand-Duchesne tube, the electrons are focused directly on a photographic plate, rather than on a phosphor screen.

Scientific papers reporting the results of two of the three investigations were presented at the Pittsburgh meeting of the American Astronomical Society in April. They were presented by Firor and Zirin, and by Frederick. An article, "The Rotation of the Nucleus of M31," by A. Lallemand, M. Duchesne, and Merle F. Walker, in *Publications of the Astronomical Society of the Pacific*, April, 1960, discussed results of the Lick Observatory project.

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Scientific Research

(*Continued from Page 47*)

faculty engaged in R&D, 32 per cent were engaged full-time in 1958 compared to 22 per cent in 1954.

Conducted for the National Science Foundation by the Department of Health, Education, and Welfare, Office of Education, the survey obtained data by means of questionnaires mailed to 1,916 independent and autonomous institutions of higher education in the United States.

Copies of the publication may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. for 10 cents.

N. S. F.

Morton and Anesthetics

(*Continued from Page 56*)

was the first to employ carbon dioxide as an anesthetic, successfully putting puppies asleep with it. He called the anesthetic condition "suspended animation."[5] Faraday, noted for his experiments with electricity, wrote: 'By the imprudent inspiration of ether, a gentleman was thrown into a very lethargic state, which continued with various periods of intermission for more than thirty hours, and a great depression of spirits accompanied this. . .'[6]

In 1773, Thomas Percival, who wrote the first *Code of Medical Ethics*, described in an essay "On the Medical Uses of Fixed Air" the properties of carbon dioxide in relieving the pain of raw wounds, when blown against the denuded surfaces. The first carefully conducted experiments with the object of securing local anesthesia were made by Sir Benjamin Ward Richardson (1828–1900), who did so much to place the entire matter of anesthetics upon a scientific basis. He noted the anesthetic effects of cold applied locally and studied the effects of rapid evaporation of volatile liquids in producing cold. In 1867, he introduced what has been termed 'the Richardson ether spray,' for the purpose of producing a satisfactory local anesthesia.

The aboriginal inhabitants of the highlands of South America were acquainted with these properties. Dr. Roy L. Moodie has reconstructed an early surgical operation among Incas, showing a blanket clad man using the cautery to make a cruciform incision in the scalp of a woman suffering from melancholia. The operator chewed a cud of coca leaves, the juice from which he could drop upon the wound if the pain became severe. Alexander Wood, in 1853, introduced the hypodermic syringe, without which the administration of cocaine or its derivatives would be difficult. Albert Niemann, 1858, isolated cocaine from coca leaves, while working in the laboratory of Friderich Wohler. Cocaine remained a curiosity for many years. In 1880 a British medical commission learnedly reported that the substance has no medical value, being at best merely a poor substitute for caffein. This same year, Von Anrep published a careful pharmacological study of the alkaloid, in which the local anesthetic properties were hinted at, but it remained for Dr. Carl Koller actually to demonstrate its great value. Dr. Koller has not, however, received the full credit that he deserves for his demonstration of the local anesthetic properties of cocaine.

Mesmerism, or hypnotism, is the last method of anesthesia attempted before the advent of modern surgical anesthesia. It was not so good because not every surgeon could perform it and not every patient could be anesthetized by it. The fact that mesmerism and effective anesthesia appeared at about the same time is evidence that those interested in the science of surgery realized that little further advancement could be made within some means of reducing pain.

For many years nitrous gas and ether had been used for various purposes to produce partial or complete narcosis, but Long was the first to employ effective anesthesia in a surgical operation, and by the method which became permanently and universally adopted. However, the discovery of surgical anesthesia did not rest upon a theory or a surmise, but upon an actual operation performed successfully without pain. He was first to use ether, but he failed to publish his results. Mr. R. H. Goodman gives a description of Long's operation.

> '. . . this letter written to me by Dr. C. W. Long in which he ordered the ether with which he performed the first surgical operation on a patient under the influence of that drug. A wen removed from the neck of a young man, Mr. James Venable, without giving him any pain, was the first operation with a complete success. In November, 1841, Dr. Long told me he believed an operation could be performed without patient feeling pain by giving him ether to inhale. . .'[7]

Though this description is not with many details, it is clear and conclusive, proving that this operation was painless. Doing so, probably, Long was not aware what kind of contribution he was capable of making and of all the possibilities which anesthesia opened to surgery.

The use of anesthesia marked an epoch in history, both medical and civil. Some favored it, others feared its strong effects. Man's fight against pain, culminating in the discovery of the anesthetic properties of ether, opened a new heaven and new earth to surgery. This controversy has continued for a century among proponents of Long, Morton, Jackson, and Wells. In conformity with the regulation that in science the credit goes to the man who convinces the world, not to the man to whom the idea first occurs, credit was given to William T. G. Morton.

The man who achieved this wonder, the greatest hero of the struggle against pain, was the Boston dentist W. T. G. Morton. At the age of twenty-seven he delivered us for all time from the pain of surgical operations, and thereby earned the gratitude of the world.

Morton was a complex person. He was self-confident rather than vain—but too often people tended to see him in the less favorable light. Though he never showed petty animosities on his own part, he had what amounted to a genius for arousing them against him. Fortunately for himself and the world, he was tough enough and self-assured enough to battle his way singlehanded against all opposition, and even on occasion to turn it to his advantage in attention-attracting controversy.

Before this wonderful achievement, his life ran on ordinary lines. He grew in an old-fashioned farm house, where he was born on August 9, 1819, near the Massachusetts village of Charlton. James Morton, later a Quaker from the Society of Friends in Smithfield, was determined that his son should be educated. When William was twelve, he was sent off to the neighboring town of Oxford, to be enrolled as a day student at the Oxford Academy. Being there, he often accompanied a friend-physician during his visits to sick people. Next he attended Northfield Academy taking courses in natural philosophy. They consisted of lectures on chemistry, physics, botany and geology. His work in school was inspired by Dr. Wellington. He spent many hours in Dr. Wellington's little improvised laboratory.

After a few years his study was interrupted because of some financial difficulties. He had to work for two years before he further continued his study. He enrolled as a medical student in Baltimore, where ardently he threw himself into the work. Anatomy, chemistry, pharmacy . . . —the mystery of these subjects was at last revealed to him. Again he had to face lack of money. On the advice of some of his friends he entered the College of Dental Surgery. He worked now with Dr. Wells, who also at this

time experimented with ether. During their conversations they often talked about means which could prevent pain. When Morton graduated from the College of Dentistry, both he and Wells moved to Boston. William Morton, now surgeon-dentist, set up his office and soon acquired a lucrative practice. His personal appearance might have helped him in his success. He was an uncommonly handsome man, with a determined look in his eyes, but also a kindly expression and pleasing manners. He had the daring spirit, the speculative temperament, and restless energy of the born discoverer. Already he had made improvements in the manufacture of artificial teeth. He was the first, or one of the first, to recognize the importance of chemistry in connection with the practice of medicine. He had no sooner returned to Boston than he commenced the study of chemistry with Dr. C. Jackson, spending from six to ten hours a week in his laboratory. There he became acquainted with the properties and peculiarities of most of the chemicals. He was trying all kinds of experiments on dogs and even descended to fishes and insects.

Dr. Morton, practicing in Boston, was so inspired by Wells' demonstrations with nitrous oxide at Harvard, that he decided to administer ether. He administered a mixture of sulphuric acid and alcohol to chickens and discovered that the chickens fell asleep for a long time, awakening undamaged. After several of such trials, Dr. Morton wrote: '. . . I think that it is especially noteworthy that its use may be recommended for painful illnesses, and that will mitigate the disagreeable complications of these.'[8]

Morton's marriage to Elizabeth Whitman gave him a fresh spur to his ambitions. Next time when his experiments with animals did not give him satisfactory results, he tried to use it on himself. Day after day he took longer and more dangerous doses of ether. During the early phases of his experiments, he became aware that he would never reach his end by the open inhalation of ether from a drenched handkerchief, and that some kind of apparatus would be needed to produce the sort of sleep of which he was in search. Soon he was on the track of what he wanted. He sketched the design for the inhaler, a small two necked glass globe. Into one of the necks was inserted a wooden tube controlled by tops, while the other permitted the free ingress of air. Putting the wooden tube in his mouth, the patient inhaled air across the surface of ether in the bottle, and the air became charged with ether vapor.

Morton wanted to be sure of his ground. When a major operation was performed, life was always at stake, failure would lead to death and the accidental death of the patient during the inhalation of ether might wreck Morton's scheme for the conquest of pain—and even lead the inventor to the gallows. He visited some of the most noted Boston dentists and doctors and demonstrated the new procedure. Not one of them would undertake the responsibility of using Morton's apparatus during the performance of major operations. Morton was on the go day after day; he continued to see doctors, chemists and others, making propaganda for his discovery.

There were all kinds of obstacles to the use of ether during surgical operation. For centuries medical experience in the use of narcotics had been most unfavorable; Wells' experiment with laughing gas had resulted in a fiasco; the dangers attendant upon putting a patient into an artificial sleep for a major operation were considered to be too great for any further attempts to be justifiable. Only one man supported Morton, Dr. J. C. Warren.

Morton did not stop to experiment. Not having any suitable volunteers, he had to experiment on himself. Rachel Baker in her book entitled *Dr. Morton—Pioneer in the Use of Ether,* gives us a very colorful and interesting description of Morton's work. One of his experiments proceeds as follows:

> '. . . almost at once he had a sensation of ink spreading before his eyelids. Slowly, slowly, the black flood poured out. It submerged him, and he went down, his body reeling down into fathomless depths, and a rushing sound passed his ears as he fell. At this moment, his hand with the handkerchief dropped from his mouth. He wanted to lift it—and could not. . . . He struggled to consciousness, but, as in a horrible nightmare, he could not awake. He wanted to scream, cry out for help, but his mouth could not move. His eyelids were weighted . . . his body seemed turned to stone, for there was no sensation. . . . . He waited. The tingling spread. He was able to raise his hand. His fingers sought the flesh of his thigh—he held the flesh and squeezed it. It was like squeezing clay, some alien substance. He felt nothing. In spite of his terror he felt triumphant . . . ! Slowly he lifted his head. He looked at the watch; he had been unconscious just eight minutes . . . I have done it! . . . I have done it! he cried.'[9]

On the next day, September 30, 1846, his assistants were running to the docks, to the taverns, to the jail in order to get him a subject. This time their search proved to be useful. A man named Eben Frost consented to have his tooth removed under influence of ether. The next morning, in the *Boston Daily Journal* of October 1, 1846, appeared the news: 'Last evening, as we were informed by a gentleman who witnessed the operation, an ulcerated tooth was extracted from the mouth of an individual without giving him the slightest pain. He was put into a kind of sleep by inhaling a preparation the effects of which lasted about three-fourths of a minute. It was long enough to extract a tooth!'[10] This announcement did not excite Boston. Like all important discoveries it went by unnoticed. From the moment when his tooth was extracted under ether, Frost's life belonged to the great discovery. He was the first person to whom the blessings of ether narcosis were vouchsafed. He was the first and principal witness to show that Morton's discovery was free from risk and genuinely effective.

Though this news did not evoke popular interest, there were some who became anxious to find more about it. One of them was a young surgeon, Dr. H. J. Bigelow. He wanted answers to such questions as: 'What was it? . . . How does it work? . . . Was it possible? . . . Was the ages-old problem of surgery solved?' Discussing these and other problems with Dr. Morton, he praised his work and encouraged him to continue this.

Dr. Morton, now fully confident in his victory, asked to be allowed by the authorities of the Massachusetts General Hospital to demonstrate his so called 'wonder drug.' Permission was granted to Morton to try the anesthetic for the removal of a tumor on the neck of a young patient, and October 16, 1846, was set as the day for the operation. Because of undetermined circumstances, Morton did not appear on schedule and he was prepared to leave the town. His behavior can be understood in terms of the responsi-

bility before him. He feared failure before that well-qualified and critical audience. Next day, however, he came to the hospital to fulfill this important historical event.

Dr. Warren, always sympathizing with Morton, before the operation said to the audience: '. . . on every instance when the knife was applied to the live tissue, there was pain. . . And now we have a gentleman here who tells us that he has a liquid preparation, the inhalation of which does away entirely with pain in the operation. Morton, a dentist of this city, wished for the opportunity to test its power in surgical operation.'[11] This introduction did not meet proper acceptance from the audience. Some remarked: 'A miracle worker whose miracle will not come off.'[12]

After operation was completed, people enthusiastically congratulated Morton and Dr. Warren pronounced with cutting clarity: 'Gentlemen, this is no humbug!'[13] The others shared in the general enthusiasm. Those, who, at first, had been skeptical and scornful were carried away in the stream. Surrounding the young dentist, they congratulated him and overwhelmed him with questions. Dr. Morton, probably, trembling with excitement stood among them, answering to the best of his ability, relating his numerous experiences, explaining how he had happened upon the discovery. This must have been the happiest moment in his life.

After this demonstration, Morton gave up his dental practice and devoted all his time to the anesthesia. He also began to manufacture anesthetic equipment. His opponents were against these events. 'Something must be done forthwith to put an end to such proceedings which would be a scandal to our traditions,' said the member of the Medical Society. 'We cannot allow Professor Warren, in his credulity and out of the kindness of his heart, to become a tool of this avaricious little dentist!'[14]

Boston was, indeed, proud to have been the starting point of the new method. Day after day articles appeared in the local papers describing the importance of what had been achieved.

Morton's fluid still needed an appropriate name. Morton and his friends discussed what it was to be called. They proposed *Latheon*, from the river Lathe of Greek mythology, a draught of whose waters could expunge all painful memories. The men of science present on the occasion agreed with Morton that this practical name was most apt. But Oliver Wendall Holmes, himself a poet, was unsatisfied, for he thought it would be better, since this was a scientific discovery, to find a name in the vocabulary of science. He promised to see what he could devise. The very next day he hit upon a name. Writing to Morton under date November 21, 1846, he said:

> 'Dear Sir, Everybody wants to have a hand in a great discovery. All I do is to give you a hint or two, as to names, or the name, to be applied to the state produced, and the agent. The state should, I think, be called *Anesthesia* . . . . The adjective will be *anesthetic*. Thus we might say the state of anesthesia, or the anesthetic state . . . I would have a name pretty soon, and consult some accomplished scholars, such as President Everett or Dr. Bigelow, senior, before fixing upon the terms which will be repeated by the tongue of every civilization . . . . Respectfully yours, Oliver W. Holmes.'[15]

Doctor Morton's fame spread throughout the United States. The most active hostility was shown in the South.

Many objections were voiced from the religious side, and the attempt to subdue it was impious. None of the objectors, however, were able to stop the victorious march of the great discovery. The newspapers and medical faculties of major cities welcomed the new discovery with the same enthusiasm. The whole of America, the whole world, was soon to join the common appraisal.

In the *Lancet* we read: 'The discovery of Dr. Morton more striking to the general than to the scientific mind, will undoubtedly be placed high among the blessings of human knowledge and discovery. That its discoverer should be an American should be a high honor to our transatlantic brethren; next to the discovery of Franklin, it is the second and greatest contribution of the New World to science, and it is the first great addition to the medical art. Dr. Morton deserves, if his discovery stands the test of time, the gratitude and reward of every civilized people and government upon the face of the earth.'[16]

European countries and the rest of the world have lagged behind in the widespread adoption of general anesthesia. In those days operations were still something to be frightened about. In Germany, for example, people were more reliant on prayer than on a narcotic. But when, in Erlangen, on January 24, 1847, Dr. Heyfelder performed the first painless operation to be made in Germany, the discovery was enthusiastically acclaimed.

Meanwhile, a patent was issued to Dr. Morton on November 12, 1846 and on December 21, 1846, he secured an English patent through an English subject named Dore, who at once assigned his rights to Morton. The first sentence of the patent reads: 'Be it known that we, Charles T. Jackson and William T. G. Morton, of Boston . . . . have invented or discovered a new and useful improvement in surgical operations.'[17]

Jackson withdrew his name from the patent on the condition the he be paid $500.00 and should receive ten per cent of the profit.

Morton was attacked. His enemies sought revenge. In ten years after his victory was made public, he was a ruined man. His slender means were exhausted. In the autumn of 1862 he joined the army of the Potomac as a volunteer surgeon, and applied ether to more than two thousand wounded soldiers during the battles. In July 1868, a torrid wave swept over the Northern states which carried off many. Dr. Morton was one who suffered from it. He now lies in Mount Auburn Cemetery, with a modest monument over his grave: 'William T. G. Morton, inventor and revealer of anesthesia, by whom pain in surgery was arrested and before whom, in all time, surgery was agony, since whom, science has control of pain.'[18]

Morton wooed his success more exuberantly and won it more enormously than anyone else in Britain or America, pursuing it all at once in several continents of space and half a dozen continents of mind. The prestige of the Massachusetts General Hospital and the support of such leaders in the medical world as Warren, Hayward, and Bigelow accounted for the rapid headway of surgical anesthesia throughout all civilized countries. Every individual praises anesthetics and their inventor. Many distinguished scientists and common people think about narcosis as of a

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Morton and Anesthetics

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miracle. Charles Darwin, for example, asked what he considered the most important discovery of the nineteenth century, replied: . . . Painless surgery!

Morton's discovery was overwhelmingly important. Its greatness snatched him out of the sphere of little things, imposed greatness upon him, so that, by the caprice of fate, the little dentist of Boston became one of the supreme benefactors of mankind.

In quick succession new development in anesthetics followed. For the past hundred years ether has held top position among the general anesthetics. Despite its many disadvantages, it has remained popular not from choice, but from necessity. No other general anesthetic has been discovered yet that possesses the relation-producing properties of ether. The following list of dates shows the advances in anesthesiology:

1844—Anesthesia discovered by H. Wells
1846—Ether anesthesia first used by W. Morton
1853—Invention of hypodermic syringe and hollow needle
1873—Anesthetic properties of cocaine demonstrated
1876—Nitrous oxide used for induction followed by ether
1880—Nitrous oxide first used in obstetrics
1882—Discovery of cyclopropane
1885—First spinal anesthetic introduced in the United States
1904—Novocaine discovered in Germany by Einhorn
1913—Introduction of sacro-caudal analgesia
1926—Avertin first used for rectal anesthesia
1932—Evipal first introduced by Hans Weese of Germany
1933—Cyclopropane used clinically for the first time by Waters
1934—Pentothal sodium introduced by John S. Lundy at Mayo Clinic
1940—Introduction of continuous spinal analgesia by Lammon
1943—First use of curare in anesthesia by Griffith of Canada
1945—Anesthetic properties of N-propyl methyl ether (Metopryl) first investigated by John Krantz, Jr., and used for the first time by Sylvane M. Shane.

The year 1946 marked the century of the discovery of ether anesthesia. Today the science and art of anesthetics are so far advanced that the earlier fears associated with anesthesia need not be a source of apprehension to those requiring surgery. Modern methods and the administration of newer anesthetic agents have become so complex that a new specialty has arisen, that of anesthesiology.

NOTES

[1] C. H. La Wall, *Four Thousand Years of Pharmacy*, J. B. Lippincott Co., Philadelphia, page 116.
[2] La Wall, *Four Thousand Years of Pharmacy*, p. 118.
[3] G. Ostlere, *Anesthetics and the Patient*, St. Ann's Press, Timperley, 1949.
[4] Tulip-Miller, Rene, *Triumph Over Pain*, the Bobbs-Merrill Co., New York, 1941.
[5] F. K. Boland, *The First Anesthetic* (The Story of C. Long), University of Georgia Press, Athens, 1950, pp. 150–151.
[6] Ibid., p. 151.
[7] Boland, *The First Anesthetic*, pp. 242–250.
[8] Shane, Sylvan M., *Anesthesia—Thief of Pain*, Vantage Press, New York, 1956, p. 74.
[9] Baker, Rachel, *Dr. Morton—Pioneer in the Use of Ether*, Julian Messner, Inc., New York, 1946, page 115.
[10] Baker, op. cit., p. 180.
[11] Shane, Sylvan, *Anesthesia—Thief of Pain*, Vantage Press, New York, 1956, page 84.
[12] Ibid.
[13] Ibid.
[14] Tulop-Miller, Rene, *Triumph Over Pain*, The Bobbs-Merrill Company, New York, 1938, page 185.
[15] Ibid., page 187.
[16] Tulop-Miller, *Triumph Over Pain*, page 312.
[17] Stearns,, *Sketches*, page 119.
[18] Ibid.

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Baby ware and toys that can be boiled and sterilized as often as necessary without distorting, cracking, or changing color, are being marketed. Molded of a thermoplastic molding compound, these products include a dish, bowl, cup and rattle molded in the shape of a rabbit; a coin bank in the shape of numbers and animals.

* * *

Nylon resin is now being manufactured for children's roller skates. Lightweight, the ball bearing skates are claimed to reduce the number of parts to about 17 molded parts. Standard skates contain as many as 100. For indoor or outdoor use, the skates come in color.

—*Chemical News*